NAVAL POSTGRADUATE SCHOOL
Monterey, California

THESIS

A TAXONOMICAL STRUCTURE FOR CLASSIFYING THE GOODS PURCHASED BY THE FEDERAL GOVERNMENT

by

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December, 1990

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SECURITY CLASSIFICATION OF THIS PAGE

REPORT DOCUMENTATION PAGE

1a REPORT SECURITY CLASSIFICATION UNCLASSIFIED	1b RESTRICTIVE MARKINGS
2a SECURITY CLASSIFICATION AUTHORITY	3 DISTRIBUTION/AVAILABILITY OF REPORT Approved for public release; distribution is unlimited.
2b DECLASSIFICATION/DOWNGRADING SCHEDULE	
4 PERFORMING ORGANIZATION REPORT NUMBER(S)	5 MONITORING ORGANIZATION REPORT NUMBER(S)
6a NAME OF PERFORMING ORGANIZATION Naval Postgraduate School 6b OFFICE SYMBOL (*If applicable*) AS	7a NAME OF MONITORING ORGANIZATION Naval Postgraduate School
6c ADDRESS (*City, State, and ZIP Code*) Monterey, CA 93943-5000	7b ADDRESS (*City, State, and ZIP Code*) Monterey, CA 93943-5000
8a NAME OF FUNDING/SPONSORING ORGANIZATION 8b OFFICE SYMBOL (*If applicable*)	9 PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER
8c ADDRESS (*City, State, and ZIP Code*)	10 SOURCE OF FUNDING NUMBERS Program Element No / Project No / Task No / Work Unit Accession Number

11 TITLE (*Include Security Classification*)
A Taxonomical Structure for Classifying the Goods Purchased by the Federal Government

12 PERSONAL AUTHOR(S) Brian L. Wenger

13a TYPE OF REPORT	13b TIME COVERED	14 DATE OF REPORT (*year, month, day*)	15 PAGE COUNT
Master's Thesis	From To	December 1990	144

16 SUPPLEMENTARY NOTATION
The views expressed in this thesis are those of the author and do not reflect the official policy or position of the Department of Defense or the U.S. Government.

17 COSATI CODES			18 SUBJECT TERMS (*continue on reverse if necessary and identify by block number*)
FIELD	GROUP	SUBGROUP	Government Goods Taxonomy; Taxonomy; Classification System for Government Goods; Cluster Analysis

19 ABSTRACT (*continue on reverse if necessary and identify by block number*)

This thesis is an attempt to develop a taxonomical structure to use in the classification of the goods purchased by the Federal Government. The primary objective was to develop a usable scheme that practitioners could employ in classifying goods along a continuum from simple to complex. A secondary objective of this thesis was to determine the characteristics of the goods, other than their obvious physical differences, to utilize in classifying. Using 21 randomly selected heterogeneous goods and a scaling process, a survey was conducted to determine the relationship between these goods and the chosen characteristics. Cluster analysis was then utilized to group the goods into categories that exhibited similar characteristics. As a result of the research, a taxonomical structure for classifying the population of Government goods into five categories was developed. The potential benefits from using such a scheme could arise in the staffing and directing of procurement functions, training and education of the acquisition workforce, and refinement of procurement policy. It is recommended that the taxonomical model resulting from this research be validated and refined through further use

20 DISTRIBUTION/AVAILABILITY OF ABSTRACT	21 ABSTRACT SECURITY CLASSIFICATION	
☒ UNCLASSIFIED UNLIMITED ☐ SAME AS REPORT ☐ DTIC USERS	Unclassified	
22a NAME OF RESPONSIBLE INDIVIDUAL David V. Lamm	22b TELEPHONE (*Include Area code*) (408)646-2775	22c OFFICE SYMBOL AS/Lt

DD FORM 1473, 84 MAR — 83 APR edition may be used until exhausted. All other editions are obsolete.

SECURITY CLASSIFICATION OF THIS PAGE
UNCLASSIFIED

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A Taxonomical Structure for Classifying the Goods Purchased by the Federal Government

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Submitted in partial fulfillment
of the requirements for the degree of

MASTER OF SCIENCE IN MANAGEMENT

from the

NAVAL POSTGRADUATE SCHOOL
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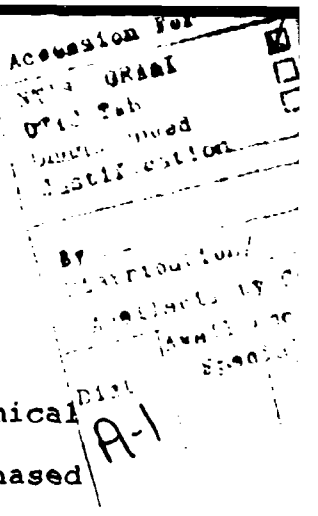

ABSTRACT

This thesis is an attempt to develop a taxonomical structure to use in the classification of the goods purchased by the Federal Government. The primary objective was to develop a usable scheme that practitioners could employ in classifying goods along a continuum from simple to complex.

A secondary objective of this thesis was to determine the characteristics of the goods, other than their obvious physical differences, to utilize in classifying. Using 21 randomly selected heterogeneous goods and a scaling process, a survey was conducted to determine the relationship between these goods and the chosen characteristics. Cluster analysis was then utilized to group the goods into categories that exhibited similar characteristics.

As a result of the research, a taxonomical structure for classifying the population of Government goods into five categories was developed. The potential benefits from using such a scheme could arise in the staffing and directing of procurement functions, training and education of the acquisition workforce, and refinement of procurement policy. It is recommended that the taxonomical model resulting from this research be validated and refined through further use.

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I. INTRODUCTION

A. BACKGROUND

Many researchers in the field of Government procurement have proposed that contracting is a science. One of the major requirements of a science is a description and classification of the subject matter (Park, 1986, p.90).

The paramount purpose for classification is to describe the structure and relationship of the constituent objects to each other and to similar objects. From this, relationships are simplified in such a way that general statements can be made about the classes of objects (Hunt, 1983, p. 349).

Several studies have been done on classification within the Federal procurement environment. Some of these have focused on the classification of tasks done by the contracting officer (Fowler, 1987 and Page, 1989). Another has proposed a classification of contracting literature (Sweeney, 1989).

While the result of these taxonomical studies have been significant, they do not exhaust all the ways of beneficially classifying the contracting subject matter. Another possible taxonomical approach is one based on the type of good procured by the Federal Government. Certainly, as one of the major elements of the subject matter, goods represent an area where classification efforts appear to be few and limited.

A major problem today in procurement is that Government purchased goods are quite often perceived by legislators and critics of the procurement process as a single homogenous grouping (Judson, 1986, p.14). Frequently when additional oversight is mandated, there is little thought given to the difference in product complexity or procurement procedures involved.

If in classifying, the perspective taken were to view goods from simple to complex, goods could then be described in such a manner that a categorization along the continuum between the two extremes is possible. With the wide variety of items, simple versus complex or common versus unique, procured by the Government, there should be a way to categorically classify these goods in a useful structure. Such a structure or classification scheme would allow for a systematic categorization of contracting goods across a spectrum from the relatively simple, off-the-shelf type items, to sophisticated and complex weapon systems.

The major benefits of this study will be that accurate questions can be asked on how the perceived order of goods has arisen and how best do we maintain or improve it. A classification model provides the structure necessary for identifying all the various types of Government purchased goods in a profile that lends itself to increased visibility. The treatment of these goods, on a whole, as a homogenous

group will be much more difficult with a taxonomical structure that highlights the differences.

Accurate determination of the best procurement strategy for buying certain products is another benefit of having a goods classification scheme. For example, contracting officers can determine which specific group of buyers (e.g. those familiar with commodity-type buying versus buyers of weapon systems) and which acquisition methods would be most effective. Likewise, researchers will have a structure for adequately addressing the differences in contracting goods based on their characteristics.

B. OBJECTIVES

The overall objective of this research is to develop a scheme that can be used to classify Government goods on a strategic basis. This scheme should provide for distinction between the various classes of goods and identify the categories within the boundaries of the polar extremes.

Specific objectives to be achieved in this study include:

1. The application of taxonomic efforts in market research.
2. Determining the characteristics of the goods, other than their obvious physical differences, to use in classifying.
3. Developing procedures for comparing a sample group of goods with the chosen characteristics.
4. Testing of the procedures by use in actual data collection.

5. Deriving a taxonomical model based on the data analysis.

C. RESEARCH QUESTIONS

The following specific questions were addressed during this study.

Primary:

What would be the essential characteristics or features of a taxonomical structure that would classify the goods purchased by the Federal Government?

Subsidiary:

1. What steps or procedures should be considered in developing a classification scheme for Government purchased goods?
2. What are some of the distinguishable characteristics of the goods procured by the Federal Government?
3. Which properties or characteristics of the goods are the most important for classification purposes?
4. What should be the decision criteria for classifying Government purchased goods?
5. What are the various homogenous categories of goods procured by the Government?
6. In what areas of Government procurement will this classification scheme be useful?
7. What would a taxonomical structure for classifying Government goods consist of?

D. RESEARCH METHODOLOGY

The research employed in this study was primarily qualitative and involved six major components: a) comprehensive literature review; b) determination of the

characteristics to use in the classification effort; c) development of the procedures to allow for comparison between Government goods and the characteristics; d) testing of the procedures by use in actual data collection; e) cluster analysis of the data and f) determination of a proposed taxonomical model.

The researcher first began the research effort with a comprehensive and in-depth review of the available literature on the subjects of taxonomies and classification schemes. During this review a number of classification schemes were discovered, however, little information was available on the formation or application of the models. Additionally, most of these classification approaches were from the perspective of a market researcher. As explained in Chapter II, the Government's Federal Supply Class and Standard Industrial Classification systems were examined but rejected as possible classification methods for this thesis.

To examine and determine the characteristics to use in classifying Government goods, the researcher first developed a preliminary listing of attributes based primarily on the literature. This list was then submitted to and discussed with a select group of contracting experts. The end-result of this expert panel review was a refined listing of characteristics on which to base the classification effort. Chapter III discusses the pertinent details of how these characteristics were generated and refined.

As the next major stage, a process for comparing goods with the characteristics was developed. This first entailed defining the characteristics in a concise, understandable manner. Then, since cluster analysis techniques were going to be used to analyze the data, the characteristics were quantified by using ordinal scales. Finally, a matrix was designed to allow for a good-by-good comparison with the characteristics. This entire procedure is further described in Chapter III.

The matrix was then used to collect data relative to 21 heterogenous Government goods by submitting it to a larger and distinct body of acquisition experts. Cluster analysis was used on the resultant data and ultimately led to categorization of the 21 goods. Chapters IV and V recount in further detail the data collection and analysis process.

Finally, based on the results of the cluster analysis, the model was streamlined to allow for ease of use and more refined results. Also, the resultant analysis led to a proposed taxonomical structure that can be used in future classification efforts. Both areas are described in Chapter V.

E. SCOPE, LIMITATIONS, AND ASSUMPTIONS

The scope of this study is the development of a model for classifying, from a strategic perspective, the goods purchased by the Federal Government. With this scope, classification

effort within the area of market research was concentrated upon since this is one of the primary fields where strategic classification is pursued. While this concentration did not supply any specific models that directly applied to this research effort, sufficient information was available to provide a foundation on which to develop the model.

The following assumptions apply:

1. Characteristics of Government goods exist that lend themselves to ordinal scaling.
2. All Government goods can be classified.
3. A framework can be developed to allow for repetitive classification efforts.

The following limitations will apply:

1. Because of time constraints, the thesis effort will stop short of actually classifying all the Government goods.
2. The model will not cover the various services purchased by the Government since the characteristics and categories of services are quite different from goods.
3. The results of this research, due to the diversity among Government goods and the expertise necessary to classify, should be considered as an introductory goods classification model.

F. LITERATURE REVIEW

Taxonomies Of Human Performance: The Description of Human Tasks, by Edwin A. Fleishman and Marilyn K. Quaintance was one of the primary works used in this study. Although not directly related to the subject matter, this work provided a

significant amount of background information on developing classification schemes.

Outside of various journal articles, however, there is very little information available on constructing classification schemes for goods. Of those few that were found, the most beneficial was Gordon Miracle's "Product Characteristics and Marketing Strategy." This article provided a basis to begin thinking about the categories in which to classify goods and some of their possible characteristics.

In the application of cluster analysis techniques, the researcher used two key references. The first was H. Charles Romesburg's Cluster Analysis for Researchers. This work provided a few examples where clustering techniques were used to generate classification schemes. The second, SAS/STAT Guide for Personal Computers, edited by J. Chris Parker, proved helpful in the actual performance of the clustering iterations.

G. ORGANIZATION OF STUDY

This study was undertaken in an effort to produce a method for categorizing, in a concise manner, the goods the Government buys. In Chapter II, the reasons for classifying are discussed along with some general classification principles. The chapter concludes with an examination of the need for a strategic goods classification scheme.

In Chapter III, the conceptual basis for the classification model along with the determination of the characteristics is detailed. Also presented is the determination of an approach, a goods versus characteristics matrix, for comparing goods with the characteristics. The chapter concludes with a pre-test and revisions to the matrix model.

Chapter IV discusses how the matrix was used as a survey questionnaire to collect data on the relationship between the characteristics and 21 sample Government goods. The chapter further delineates preliminary cluster analysis results of the data as compared to an "a priori" categorization of the goods. Chapter IV closes with a discussion on how the clustering results were validated and the decision to use five categories in which to group the goods.

Chapter V continues then with the cluster analysis of the 21 sample goods. The main objective of these iterations is to simplify the classification process. Simplification is achieved primarily by reducing the number of attributes from the matrix model. Based on the streamlining effort and the data relative to the 21 goods, a five-category, six-characteristic classification scheme is proposed.

Finally, Chapter VI presents the conclusions and recommendations of the researcher regarding this research effort.

II. TAXONOMY BACKGROUND

A. INTRCDUCTION

Classifications, in general, have arisen out of the need to bring order and systematic arrangement to objects or ideas. Classifications not only arrange items but also are "one of the simplest methods of discovering order in the bewildering multiplicity of nature." (Rao and Lingaraj, 1988, p. 81)

The science of classification goes back to the ancient Greeks. Plato and later his student Aristotle used classification systems to reveal the universal order of nature consisting of various kinds of genus, species and subspecies. (Fleishman and Quaintance, 1984, p. 19)

Most early classification efforts such as Linnaeus and Darwin dealt with biological categorization. Plants and animals were frequently classified into different groupings to permit a better and more logical understanding of their relationships. (Fleishman and Quaintance, 1984, p. 19)

Researchers in the field of psychology were also one of the first to use classification schemes to make their discipline more systematic (Fleishman and Quaintance, 1984, p. 30). This systematic arrangement of the subject matter is in deed, one of the requirements for a body of knowledge to

become a science and one of the first methods to be employed (Rao and Lingaraj, 1988, p. 81).

Taxonomies and their classification schemes are a major effort of fulfilling this requirement. Classification schemes play fundamental roles in the development of a discipline since they are the primary means for organizing phenomena into classes or groups that are agreeable with systematic investigation and theory development. (Hunt, 1983, p. 348)

B. DEFINITION OF TERMS

To guard against any misunderstanding, the definitions of several key terms is necessary.

For this work, classification will be defined as the ordering or arrangement of objects into groups or sets on the basis of their relationships (Sokal, 1974, p. 1116). These relationships can be based on observable or inferred properties.

The end result of the classification process is then identified as the classificatory system. Generally, this classificatory system is a set of categories or taxa. (Fleishman and Quaintance, 1984, p. 22)

A taxonomy then encompasses the process and the end product of the set of taxa as the theoretical study of systematic classifications. This includes the classification's bases, principles, procedures, and rules. (Fleishman and Quaintance, 1984, p. 22)

Since this research effort deals specifically with classifying goods the Government buys, a definition of a good is also offered. Webster's definition of a good is something that has economic utility or satisfies an economic want (Woolf, 1975, p. 495). Within the context of this effort, a good will be defined as a tangible item purchased by the Government to satisfy a need or requirement.

C. WHY WE CLASSIFY

Before specifically addressing classifying goods, it is helpful to know from a general sense why objects, ideas, or any item of interest are classified. Classifications, in general, are used to achieve four objectives. They are:

1. Economy of memory.
2. Ease of manipulation.
3. Ease of information retrieval.
4. Description of the structure and relationship of constituent objects. (Sokal, 1974, p. 1116)

Economy of memory is achieved by using classifications to group numerous individual objects into a category that subsumes the individual descriptions of the objects contained within it. For example, it is much easier and more efficient to remember the basic characteristics of species of animals rather than the characteristics of the individual beasts that make up the category.

Classifications also provide ease of manipulation because the objects are arranged in systems in which the several taxa can be easily named and related to each other. However, classification schemes can be quite complex making this objective of manipulation quite difficult. Therefore, the third objective, ease of information retrieval, becomes important especially in the complex systems.

The most important classificatory objective is to describe the structure and relationship of the constituent objects to each other and to similar objects. These relationships then can be simplified so that general statements can be made about classes of objects. Grouping a large number of similar items together into categories and then making policy decisions, statements, or generating hypotheses is the real power of classification.

D. TWO GENERAL TYPES OF CLASSIFICATION SCHEMES

The literature generally supports two different procedures for developing classification schemes. These two methods are logical partitioning and grouping procedures. Logical partitioning results in a classification scheme developed before the researcher has analyzed any specific set of data. Hence, it is also known as a "deductive" or an "a priori" approach. (Hunt, 1983, p. 350)

Grouping procedures for classification also start with the specification of the phenomena to be classified and the

proprieties or characteristics on which the categorizing is being done (Hunt, 1983, p. 353). However, the structure of the resultant scheme is the end-result of the analysis of the data under scrutiny. In other words, the data suggest the structure and not the classifier.

Some of the more common grouping or numerical taxonomy procedures include factor analysis, multiple discriminant analysis, multidimensional scaling, and cluster analysis. While these various methods are quite different in application, all share a common property. That is, they all separate items into groups that maximize both the degree of likeness within each group (internal homogeneity) and the degree of differences between groups (mutual exclusivity). (Hunt, 1983, p. 354)

This research effort focuses primarily on the "a priori" approach but uses grouping techniques to validate the model.

E. CLASSIFICATION PRINCIPLES

Certain principles, criteria, and conditions must be present within the scheme if the classification system is to succeed.

1. Necessary Attributes of the Scheme

In an overall sense, the scheme should possess several attributes in order to meet the criteria of a successful classification. Regardless of how the scheme was developed,

either by logical partitioning or with grouping procedures, the following attributes should be present:

1. The classification scheme should adequately specify the phenomenon to be classified.
2. The scheme should adequately delineate the characteristics used in classifying.
3. The scheme's categories should be mutually exclusive.
4. The scheme's categories should be collectively exhaustive.
5. The scheme's categories should be internally homogenous.
6. The classification system must serve its purpose and be useful. (Hunt, 1983, p. 354)

First and foremost a classification scheme should indicate what exactly is being categorized. On the surface, this attribute appears rather straightforward. A scheme used to classify consumer goods does just that, or does it? Perhaps it actually classifies a consumer's perception of a good rather than the good per se.

Choosing the proper characteristics for classification purposes is another important attribute of a successful scheme. In determining the appropriateness of a characteristic, it may be best to use a filtering process for inclusion. Candidate characteristics should meet the test of differentiation of the objects, be relevant to the end-use goal, ascertainable to the user, unchanged as long as the end-use goal is unchanged, and consistently applied.

The third attribute of mutual exclusivity refers to the situation where if one item fits one category it will not fit any other class. Therefore, each item can only be classified in one place at the same level of classification. In other words, if the second level split in a hierarchical classification is all males above the age of 21 or 21 or below, a subject should not be able to be categorized in both areas.

Classification systems should also be collectively exhaustive meaning that every item classified should belong to a category. To meet this criteria, classifiers quite frequently use the catch-all category "Other". If this category becomes too large, however, it could be an indication that the system is flawed.

A fifth attribute of a successful classification is internally homogenous categories. The items within the individual categories should be separate and distinct from items in other categories.

Finally, a classification system should serve its purpose and be useful. For example, classification schemes are utilized to categorize expert systems used in production and operations management so that managers can choose the system that best fits their needs (Rao and Lingaraj, 1988, p. 84). The success of the classification scheme will depend on the probability that the users will be able to determine the appropriate expert system for their situation.

F. CLASSIFICATION SCHEMES WITHIN THE GOVERNMENT

Within the Government, there are two classification schemes used for categorizing the goods the Government buys.

1. Federal Supply Class

The first of these is the Federal Supply Classification (FSC). FSC is a commodity classification which categorizes the myriad of goods by their commodity group. Groups, and classes within these groups, have been established for the universe of goods with emphasis on items known to be in the supply systems of the Federal Government. (U.S. Department of Defense, 1989, p. ii)

Presently, there are 78 groups which are subdivided into 620 classes. The primary basis for inclusion into one of the classes is the goods physical or performance characteristics. Also items that are usually requisitioned or issued together or make up a related grouping for supply management purposes are included in the same class. (U.S. Department of Defense, 1989, p. ii)

In the researcher's opinion, the primary purpose for the FSC system is division of labor. Most noticeably for the procurement of the various categories of goods, activities are organized along the commodity lines of the goods. A secondary purpose of FSC system is the facilitation of the supply support effort associated with the goods.

2. Standard Industrial Classification

The second method of classification is the Standard Industrial Classification (SIC) of establishments. The SIC scheme is organized to reflect the structure of the U.S. economy with the business establishment as the unit classified. Each establishment is classified according to its primary activity which is determined by identifying the predominant product or group of products produced or handled. (U.S. Executive Office of the President, 1987, p. 11)

The intent of the SIC system by its developers was to aid in the collection, tabulation, and presentation of statistical data relating to business establishments (U.S. Executive Office of the President, 1987, p. 11). While not truly a goods classification scheme like FSC, the SIC can be an approach used to classify goods by their manufacturer.

G. THE NEED FOR A STRATEGIC CLASSIFICATION SCHEME

While both the FSC and SIC approaches to classification serve their purpose, both do little to reveal the best strategic approach to buying Government goods. In the researcher's opinion, it would be more useful to segment goods into clusters in which the individual goods share the same end-item characteristics. These characteristics would go beyond the physical nature of the goods and focus more on the considerations deemed important in the buying process.

1. Potential Benefits of a Government Goods Classification Scheme

Classifying goods strategically from the Government buyer's perspective could yield several possible benefits. If goods were classified across a spectrum from a point where Government buyer involvement in determining price and quality was nonexistent to the point where is was necessary, then categories of goods may be identified that require less statutory and regulative oversight.

Following this simple to complex classification spectrum, another benefit would possibly be in the personnel management area. Staffing levels for Government procurement offices could be determined based on the type of goods they buy. Even if an office buys a cross-section of goods, internally it could be arranged so that individual buyers are responsible for those goods, regardless of the commodity type, that exhibit the same strategic characteristics.

Classifying Government goods strategically could also have positive industrial base implications. From a competitive and producability standpoint, industry's position would be enhanced if they were aware of the benefits demanded by the Government. A strategic classification scheme could highlight what these benefits were if developed from the buyer's perspective.

2. Strategic Classification Approaches

Classifications of goods has been a longstanding tradition of marketing theory (Bell, 1986, p. 13). In marketing, not unlike other disciplines, the need for classification schemes arose as the marketing field emerged. There are classification schemes for different kinds of goods, stores wholesalers, pricing policies and numerous others (Hunt, 1983, p. 348). Given the nature of this study, the focus of the literature research was primarily on the various goods classification schemes used in marketing.

Marketing classification schemes offer some valuable insights. First, by analyzing the schemes, one is able to determine possible characteristics to consider in classifying goods. Secondly, these classification schemes offer alternative methodologies that can be used for operationalizing the classification.

One scheme in particular, proposed by Gordon Miracle in 1965, was one of the first attempts to link a product's characteristics with marketing strategies (Miracle, 1965, p.19). Using the nine characteristics listed in Table 2-1, Miracle proposed that products could be classified into five groups (I, II, III, IV, and V). These groups were placed across a continuum or spectrum ranging from one extreme to another.

For example, Group I consisted of items like candy bars and razor blades while Group V included specialized

TABLE 2-1

Product Characteristics
Source: Miracle, 1965, p. 20

1. Unit value.
2. Significance of each individual purchase to the consumer.
3. Time and effort spent purchasing by consumers.
4. Rate of technological change.
5. Technological complexity.
6. Consumer need for service.
7. Frequency of purchase.
8. Rapidity of consumption.
9. Extent of usage.

machine tools and electronic office equipment. Table 2-2 shows the variation in product characteristics for each group.

The results of Miracle's classification model were significant. Now based on the group a product was classified into, strategic plans for marketing the item could be developed. Marketers could determine strategies for product policy, marketing channels, promotions, and pricing and then integrate them in a product marketing mix. (Miracle, 1965, p.24)

Miracle's scheme is the basis on which this research effort develops a classification scheme for Government goods. Because of the strategic implications of a good's

TABLE 2-2

Product Characteristics of Five Groups
Source: Miracle, 1965, p. 20

Product Characteristics	Group				
	I	II	III	IV	V
1	Very low	Low	Medium to high	High	Very high
2	Very low	Low	Medium	High	Very high
3	Very low	Low	Medium	High	Very high
4	Very low	Low	Medium	High	Very high
5	Very low	Low	Medium to high	High	Very high
6	Very low	Low	Medium	High	Very high
7	Very high	Medium to high	Low	Low	Very low
8	Very high	Medium to high	Low	Low	Very low
9	Very high	High	Medium to high	Low to medium	Very low

characteristics and an orientation from the buyer's perspective, Miracle's scheme provides the framework on which to approach this taxonomical effort.

H. SUMMARY

This chapter has highlighted some general taxonomic issues and also furnished background on two Government goods classification schemes. By using a strategic classification approach, several benefits in the management of the acquisition process are possible.

The next chapter focuses on the process involved in developing a strategic goods classification scheme. This process includes the conceptual basis for the classification effort, generation and definition of the characteristics, and proposed method for operationalizing the scheme.

III. DEVELOPMENT OF A TAXONOMICAL MODEL

A. INTRODUCTION

This section discusses the process used to develop a taxonomical model for the purpose of classifying Government goods. As a guideline for the model development, the researcher followed somewhat the steps outlined in Taxonomies of Human Performance by Fleishman and Quaintance. Even though this work dealt chiefly with task classification schemes, the necessary procedures used in producing a model still apply in a goods classificatory system. The steps identified were:

1. Determining the main objective for the classification effort.
2. Identifying the conceptual basis for the classification.
3. Deciding on the descriptors or characteristics.
4. Operationalizing the scheme. (Fleishman & Quaintance, 1984, p. 65)

In the remaining sections of this chapter, the researcher will address each of the areas identified in the list above as the model evolves from an idea into a workable scheme. Also, the researcher discusses how the model was pre-tested, what the results were, and the changes that were made.

B. MAIN OBJECTIVE AND CONCEPTUAL BASIS

The researcher combined the first two steps, objective and conceptual basis, because they are so closely related. The objective or why a person should classify along certain lines forms the basis on which the classification effort is developed.

As was mentioned earlier in this work, the objective at the outset was to classify goods on a basis other than their commodity type or manufacturer's industry. In order to provide the most information for the purposes of defining contracting policies and methods, classifying goods based on different characteristics was necessary.

The conceptual basis, therefore, for this scheme was classifying Government goods in a way that offered the most strategic insight. With this in mind, the classification scheme should highlight the various categories of goods and their related characteristics to allow streamlining and tailoring of contracting policies, methodology, and procedures.

C. DETERMINATION OF THE CHARACTERISTICS

Having identified the objective and basis for the classification effort, the next step was deciding which characteristics to use. In the researcher's opinion, this was probably the most crucial stage of the model evolution.

Depending on which characteristics are used and how they are applied, the categories that result may be quite varied.

Fleishman and Quaintance identify a strategy for determining the appropriate characteristics that the researcher used in this effort. This strategy involves specifying the characteristics that are likely to differentiate the relevant classes and are of some practical concern within the context of the classification effort (Fleishman & Quaintance, 1984, p. 65). Because of the conceptual basis of the scheme, it was necessary to identify those characteristics of Government goods that have the greatest influence on the buying process.

With this strategy as a guide, the researcher employed a three-step procedure to decide on the characteristics to use in the classification model. First, a preliminary listing of characteristics was developed. Next, this listing was submitted to and discussed with several experts in the contracting field. Lastly, based on these discussions, the researcher made the determination of which characteristics to include in the interim model that would be pre-tested.

1. Preliminary Listing of Characteristics

For the Government goods scheme, characteristics that differentiate goods while at the same time provide strategic insight were needed. To come up with the characteristics to use in the classification effort, the researcher generated a

preliminary list of twenty-two characteristics based on literature review and the researcher's own experience. These characteristics are listed in Table 3-1.

TABLE 3-1

Preliminary Characteristics
Source: Miracle, 1965, p.19 and Judson, 1986, p.15

1. Unit value.
2. Significance of each individual purchase to the Government.
3. Time and effort spent purchasing by the buyer.
4. Rate of technological change.
5. Technical complexity.
6. Need for service (before, during, or after sale).
7. Frequency of purchase.
8. Rapidity of consumption.
9. Extent of usage (number and variety of users and variety of ways in which the good provides utility).
10. Amount of price negotiation.
11. Alternative sources availability.
12. Degree of contractor financing required.
13. Amount of product homogeneity.
14. Factors considered by the buyer (price, quality, availability, and technology).
15. What determines price.
16. Amount of choice available to the buyer.
17. Stability of requirements.
18. Amount of short-range versus long-range planning involved.
19. Usage - planned and useful consumption or acquired as "insurance" (i.e., major weapon systems).
20. Extent to which goods are customized.
21. Extent to which buyer exercises judgement in meeting needs of requiring activity.
22. What is the nature of the demand for the good relative to

To assist in the characteristic generation, the researcher used a filtering model to judge the appropriateness of each characteristic. This model suggests that every

characteristic used in the classification scheme must possess certain traits. These traits include:

1. Differentiation - the characteristic should have the ability to segregate the good into at least two different classes.
2. Concomitance - the characteristics should be related to the goods.
3. Relevance - each characteristic should be valid and support the end-use goal(s).
4. Ascertainability - each characteristic should allow the user of the classification scheme to precisely determine the presence of the characteristic and the degree.
5. Permanence - the characteristic should be present and definable.
6. Consistency - the application of the characteristic should be the same for various types of items. (Sobczack, 1978, p.9)

At this point in the research effort, the idea was not to list the domain of the goods' characteristics. Rather, the objective was to offer a fairly accurate listing of characteristics that would foster creative thinking among the experts. Then, through the interview process with the experts, the characteristics could be modified as necessary to end up with a group to use in the classification effort.

2. Expert Panel Selection and Interviews

Twelve expert panel members were selected from approximately 700 National Contract Management Association (NCMA) Fellows. These individuals, listed in Appendix A, were chosen based on their Government contracting expertise and

their previous involvement with research effort associated with investigating contracting as a science.

Prior to conducting the interviews, each panel member was sent a background package concerning the research and what would be requested from them during the interview. Besides an introductory letter, the package included basic classification principles, some potential benefits from the proposed scheme, and the preliminary listing of characteristics. A copy of this package can be found in Appendix A.

Also included for the interviewees' benefit were some of the general topic areas, in the form of questions, that the researcher would try to address. The intent was not, at this point in the taxonomical process, to determine precise answers for each of these individual questions. Instead, the questions were intended to provide the interviewees ways to think about Government goods and their related characteristics.

Telephone interviews were conducted during the period of 11 July through 3 August 1990. The outcome of the interviews led the researcher to consider other characteristics for the classification scheme and question some of those included in the preliminary listing.

3. Analysis of Characteristics

Several panel members provided recommendations for characteristics or their own definitions of characteristics

already listed. Table 3-2 lists the new characteristics that the various experts suggested that the researcher consider in addition to those included in the preliminary listing.

TABLE 3-2

Panel Recommended Characteristics
Source: Researcher's Analysis

1.	Physical Description
2.	Utilization
3.	Modify old or need new system
4.	Tri-service application
5.	Criticality
6.	Whether using performance or design specifications
7.	Bulk versus single-item attention
8.	Documentation requirements
9.	Logistics consideration
10.	Requirement of the item
11.	Environment in which the item will be used
12.	Environmental impact from the good

With the additional characteristics, the researcher decided to group, based on his own perceptions, the characteristics into three dimensions. This would help in analyzing the attributes and in identifying any repetition or overlap.

It appeared that several of the characteristics were descriptors of the goods per se, others were associated more with the buying process, and finally some described the

environment of the goods. Also at this point, the researcher shortened the characteristics into a one or two word key word(s) phrase that would concisely yet accurately describe the attribute. The results are listed in Table 3-3.

As shown in this table, the goods' dimension was divided into two subcategories; inherent and external to the good. Inherent characteristics are those that could be directly identified to the good and would not depend on outside influence to determine its presence or absence. External characteristics include those that remain, to a large extent, related to the good but require some outside influence to recognize if the characteristic is present or not.

For example, the complexity of a good depends upon its component features, what the good is made of, and the other elements within the good itself. A property such as unit value also depends on a good's inherent features. However, external factors, such as the marketplace, also play a part in the value determination.

4. Selection of a Dimension Upon Which to Classify

These three dimensions: environment, goods, and buyer's effort, are viable ways to segregate the characteristics and analyze their differences. However, to attempt to encompass all three in the same scheme was considered beyond the scope of this study. It became apparent

TABLE 3-3

Characteristics Grouped by Dimension
Source: Researcher's Analysis

CHARACTERISTICS OF THE GOODS PER SE	
INHERENT TO THE GOOD	EXTERNAL TO THE GOOD
Complexity	Unit Value
Service Requirements	Consumption
Customization	Specifications
Homogeneity	Documentation

CHARACTERISTICS OF THE BUYER'S EFFORT
Price Negotiation
Factors Considered
Planning
Item Attention
Judgement

CHARACTERISTICS OF THE ENVIRONMENT
Seller Financing
Demand vs Supply
Price Determination
Stability
Sources
Usage
Oversight
Impact

that structurally interrelating the characteristics into a workable scheme would be quite difficult if attempting to use a three dimensional approach. While useful for purposes of

analyzing the attributes, retaining three dimensions for operationalizing the scheme did not seem appropriate.

Therefore, the researcher chose at this point, to limit the classification effort to one dimension. This one dimension consisted primarily of the characteristics of the goods per se. Three additional characteristics were chosen from the environment dimension and one from the buyer's effort to arrive at a listing of 12 characteristics. Table 3-4 lists these 12 attributes.

Future classification efforts might profitably focus on the buyer's effort and environmental characteristics. A cross-relationship between the three dimensions may eventually result in a very comprehensive scheme which addresses a good from these three critical angles.

TABLE 3-4

Comprehensive Listing of Characteristics
Source: Researcher's Analysis

CHARACTERISTICS OF THE GOODS	
INHERENT TO THE GOOD	EXTERNAL TO THE GOOD
Complexity	Unit Cost
Maintainability	Consumption
Customization	Specifications
Homogeneity	Documentation
	Item Attention
	Criticality
	Stability
	Sources

"Criticality," "stability," and "sources" of supply were included from the environment dimension because they could quite easily fit within the external-to-the-good subcategory. Also, these three attributes are fairly ascertainable and support the overall end-use goal of the classificatory effort.

"Item attention" was the one attribute from the buyer's effort dimension that was included. During the interviews, this was one of the most frequently cited attributes recommended for consideration when classifying Government goods. The researcher concurred and felt that item attention could also be included in the external-to-the-good subcategory.

Another change made to the characteristics was the rewording of "unit value" to "unit cost." One of the panel members suggested this change to reduce the possibility of confusion since the intent was to focus on dollar amount. In today's contracting vernacular, the term value encompasses many considerations such as cost, performance, and maintainability.

A final alteration made to arrive at the list in Table 3-4 was the substitution of the word "maintainability" for "service requirements." Within the Government contracting arena, the term maintainability is more recognizable and understandable to most people involved with Government goods.

Also, as one panel member noted, maintainability incorporates important logistical considerations.

5. **Characteristic Definitions**

As the next step in the determination of the characteristics, the researcher defined each attribute. Based on the researcher's experience and the input received from the panel members, a one to four sentence definition was applied to each characteristic. These definitions are listed below.

1. **Complexity** describes the good's technical complexity and rate of technological change. Technical obsolescence along with a high degree of complexity become major factors in considering a good and the methodology employed in purchasing the good.

2. **Maintainability** refers to the amount and degree of maintenance and logistic considerations associated with the good. The amount and degree of each vary widely among the different types of goods.

3. **Customization** is the degree to which the good is manufactured to the buyer's unique specifications. Some goods, those that are strictly commercial, have no amount of customization while others are produced exclusively for a buyer, e.g. the Government.

4. **Homogeneity** represents the number of goods that are similar and are ready substitutes for one another. Typically, the more common the use of the good, the greater the amount of homogeneity.

5. **Unit cost** is the good's cost to the buyer. Generally speaking, as a good becomes more unique to the buyer's requirement(s), the unit cost increases.

6. **Consumption** refers to how rapidly the good is used by the buyer. Some goods are consumed on a continuing basis and require constant replenishment. Others are of a more permanent nature resulting in much less frequent buying.

7. **Specifications** represents the type of requirement the Government imposes on the seller to conform with the

various types of specification requirements. Whether it is a design, performance or functional specification, the absence or presence varies across the spectrum of goods the Government buys.

8. **Documentation** is another characteristic external to the good yet many times a necessary part of it. Frequently the Government requires substantiating documentation in the form of drawings, technical manuals, and certifications for some types of goods while for others little at all is required.

9. **Item attention** given by the buyer refers to single-item versus volume or mass buying. When a buyer deals with small dollar-value items like common bolts and rivets, the focus is on a mass quantity of these types of goods. Contrast this with the acquisition of a F-14 aircraft where the buyer's attention is focused on a single item.

10. **Criticality** represents the buying urgency associated with the good or the essentiality of having the good available for the buyer to purchase. This characteristic of a good is quite obviously dynamic and will depend on the situation in which the buy is being made.

11. **Stability** refers to the nature of the requirement. Some goods are stabile in their requirements and design. Their supply will vary little given that their end-use rate doesn't change. Other requirements change quickly and often depending on the need situation and state-of-the-art technology.

12. **Sources of supply** refers to the number of available companies that provide the same basic type of good. Some types of goods have associated with them a great number of alternate sources while others of a more specialized nature are more restrictive.

D. OPERATIONALIZING THE SCHEME

With the characteristics to be used in classifying now selected and defined, the next part of the model development process consisted of deciding upon an approach for applying the characteristics to the goods.

1. Decision Tree Approach

The researcher at first considered a decision tree approach to classifying the goods. Initially, the decision tree appeared to lend itself to a hierarchical classificatory scheme with Government goods at the top and several subcategories below. For example, goods could be the first level, the second level could be those goods above and below $100,000, the third level could be those goods available from a certain number of sources, and so on.

However, after trying to apply the decision tree approach to the characteristics, it became apparent that problems would develop. Not every characteristic chosen by the researcher would lend itself to a clear-cut, over-or-below type decision. Several attributes appeared to be present in varying degrees rather than discrete amounts. Also by using a decision tree, the scheme may have to be limited to just three or four characteristics to keep the structure from becoming too cumbersome.

2. Matrix Approach To Classifying Government Goods

A matrix that could relate goods and characteristics was the second potential method for operationalizing the scheme that the researcher analyzed and ultimately settled upon. The advantage of using a matrix is that it holds an intuitive appeal of an uncomplicated visual presentation. (Hafer, 1987, p. 31)

The matrix used in this research effort allows a classifier the opportunity to compare a good with its various characteristics. Also, the matrix is itself a tool for data collection because classifiers can use it to record the relationship, if quantified, between the goods and the attributes. These quantified relationships can then be analyzed using cluster analysis techniques to determine the resultant "clusters" or categories of objects. (Romesburg, 1984, p. 33)

3. Scaling the Characteristics

In order to use a matrix as proposed in this research effort, classifiers must quantitatively express the attributes as they relate to each of the goods. The researcher, therefore, scaled each characteristic from one through five to represent the varying degrees of presence or absence of each attribute. Cluster analysis was then used to categorize or "cluster" the goods that exhibit similar characteristic values.

The main reason for choosing a five point scaling method was simplicity. Based on literature review and expert panel feedback, a classification effort such as this had not been attempted before. Therefore, the researcher's goal was to develop a workable model that was relatively simple in nature. Relating to this, the use of a larger point scale, such as seven or 10, was considered very difficult because of

the closeness between the scaling levels. For example, scorers may have difficulty discerning between the second and third increment of a 10 point scale.

The resultant scales that the researcher developed are listed below for each of the characteristics.

1. **Complexity**
   SCALE:
   1 Very low technical complexity
   2 Low technical complexity
   3 Medium technical complexity
   4 High technical complexity
   5 Very high technical complexity

2. **Maintainability**
   SCALE:
   1 No maintenance considerations
   2 Low maintenance considerations
   3 Medium maintenance considerations
   4 High maintenance considerations
   5 Very high maintenance considerations

3. **Customization**
   SCALE:
   1 No amount of customization
   2 Low degree of customization
   3 Medium amount of customization
   4 High amount of customization
   5 Made exclusively for the Government

4. **Unit cost**
   SCALE:
   1 Very low unit cost
   2 Low unit cost
   3 Medium unit cost
   4 High unit cost
   5 Very high unit cost

5. **Homogeneity**
   SCALE:
   1 Very high homogeneity
   2 High homogeneity
   3 Medium homogeneity
   4 Low homogeneity
   5 No homogeneity

6. **Consumption**
   SCALE:
   1 Very rapidly consumed good, constant replenishment
   2 Rapidly consumed good, constant replenishment
   3 Moderate consumption and replenishment
   4 Low rate of consumption and replenishment
   5 Very low rate of consumption and replenishment

7. **Specifications**
   SCALE:
   1 Completely commercial item with no specifications
   2 Mostly commercial but some accompanying requirements
   3 Moderate amount of specification requirements
   4 High amount of specification requirements
   5 Very high amount of specification requirements

8. **Documentation**
   SCALE:
   1 No associated documentation
   2 Low amount of documentation
   3 Medium amount of documentation
   4 Great deal of documentation
   5 Very high amount of documentation

9. **Item attention**
   SCALE:
   1 Complete volume-type attention
   2 Mostly volume-type attention
   3 Good that could be either volume or single item
   4 Good that is usually single-item attention
   5 Good that is always single-item attention

10. **Sources of supply**
    SCALE:
    1 Virtually unlimited number of suppliers
    2 High number of suppliers
    3 Adequate number of suppliers
    4 One or two sources
    5 No sources exist

11. **Criticality**
    SCALE:
    1 Never characterized as a critical item
    2 Rarely a critical item
    3 Sometimes approached as critical
    4 Usually characterized as critical
    5 Always purchased under critical situations

12. **Stability**
    SCALE:
    1 Good that is extremely stable

2 High degree of stability
3 Moderate amount of stability
4 Low amount of stability
5 Highly unstable good

The researcher used Miracle's product characteristics for the five categories (Table 2-2) as a basis for the arrangement of the scales. The scales are arranged in a fashion that facilitates analysis of each good ranging from "simple" to " complex". The "1" scale value for each attribute would apply in most cases to the "simple" good while the "5" value would be appropriate for the "complex" item.

4. Preliminary Taxonomical Model

The matrix shown in Figure 3-1 along with the characteristic definitions and accompanying scales represent the preliminary taxonomical model the researcher developed. The grid allows for goods, listed in the left-hand column, to be related to the characteristics shown across the top. A scorer could record the appropriate scale value for each characteristic in the cell related to the good being evaluated.

For the sample good "Steam Turbine", the numerical values shown in the row of cells on the first line represent the appropriate values from the scales for each characteristic. In this instance, the "3" in the complexity cell relates that the hypothetical scorer felt that a steam turbine was of medium technical complexity.

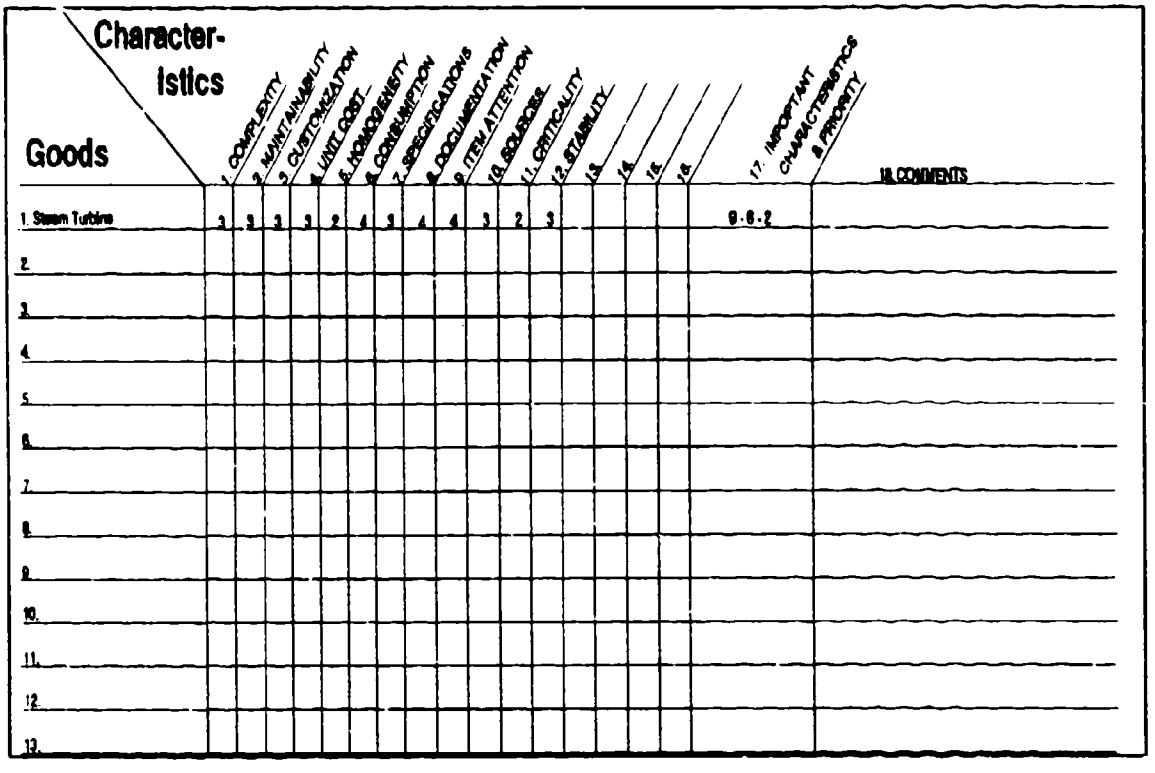

FIGURE 3-1

Preliminary Classification Model
Source: Researcher's Analysis

Because of the newness of the model, columns 13 - 16 were provided for scorers to list any additional characteristics they felt had been omitted. Also, to obtain feedback as to which characteristics were most important to the scorer, column 17 provided space to indicate the top three attributes in rank priority. Finally, column 18 could be used to provide any additional comments a scorer felt was necessary.

E. PRE-TESTING THE MODEL

The researcher pre-tested the model with a small group of reviewers before it was used for an actual classification effort. The purpose of the pre-test was to check for any inconsistencies in attribute definitions, scales, and general layout of the grid.

1. Selection of the Goods

To use the model for both pre-testing and data collection, the researcher provided the scorers with 21 Government goods to analyze. These goods, listed in Table 3-5, were selectively chosen from the various groups and classes listed in the Federal Supply Cataloging Handbook, H2-1 (U.S. Department of Defense, 1989).

The rationale behind the selection of these particular goods was twofold. First, the goods should be generally recognizable and self-explanatory to people involved in Government procurement. Also, the goods should represent an across-the-spectrum range, from simple to complex, sample. Of course, the selection at this point was based mostly on the researcher's perception of the individual goods. However, Miracle's five product categories and the examples for each also served as support for the selections made.

The researcher's intent at the end of the research process was to show that the individual goods could be grouped together in categories that exhibited similar characteristics.

TABLE 3-5

Sample Goods By Group & Class
Source: Federal Supply Classification Catalog

Group & Class	Item Name
7435	General Office Microcomputers
3930	Fork Lift Trucks
1410	Guided Missiles
5865	Electronic Countermeasure Equipment
8540	Paper Towel Dispenser
3442	Pneumatic Chisel
1950	Floating Drydock
6730	16MM Film Projector
4110	Cold Food Counter
2040	Submarine Periscopes
7110	Filing Cabinet
5350	Sandpaper
1270	Aircraft Fire-Control Embedded Computer
8950	Bottled Salad Dressing
4470	Nuclear Reactors
5961	Semi-conductor Assembly
3510	Shipboard Washing Machine
6240	Fluorescent Light Tubes
2610	Pneumatic Tire (non-aircraft)
5210	Micrometer (general purpose)
5315	Flat Washers

Therefore, at the outset, a wide range of goods was necessary to ensure that not only items at the extreme ends of spectrum but those in between were included.

The grid was expanded to allow for 21 goods to be listed rather than 13 spaces as shown in Figure 3-1 and forwarded to the pre-test group.

2. **Pre-Test Group**

The pre-test group consisted of 13 reviewers including nine of the original panel of experts and four Naval

Postgraduate School professors. The nine panel members were those who, at the time of the initial interviews, were the most receptive to the proposed research effort and had indicated a willingness to provide further assistance. The professors chosen were from the acquisition, logistics, and transportation curricula and were familiar with Government procurement.

3. Pre-test Results

Specifically, the researcher was interested in the reviewers' comments regarding what the model did or did not accomplish. Also the pre-test group was asked to look at the nature of the characteristics used and if any should be added, deleted, or modified. The following specific questions were asked of the group to gain as much useful feedback as possible.

1. Are the proposed characteristics and their associated scales legitimate? If not, what should be changed?
2. Which, if any, characteristics should be added or deleted?
3. Physical characteristics of the goods have not been included. If they were, which would be important ones to consider from the buyer's perspective?
4. Are there any other problems with this approach and/or the model that should be addressed?
5. General comments.

a. Feedback on the Characteristics and Scales

Regarding the selection and definition of the characteristics, one respondent recommended that the researcher:

> [T]hink about tightening up, and in some cases, subdividing characteristics and their definitions. Otherwise, you could get some inconsistent responses as different respondents interpret certain characteristics in different ways.

Another reviewer suggested that "complexity" be split into two separate characteristics; rate of technological change and technical complexity. Because, as this respondent related:

> [T]here are goods that are very simple, yet undergo relatively rapid technological change. For example: surf boards and skateboards.

Other respondents felt that "complexity," "maintainability," and "stability," as defined, were each covering two separate characteristics. Maintainability was referring to the complexity and the frequency of the maintenance action. As related by another reviewer, stability referred to the "variance and trending of demand and the stability of the good's design or technological change."

Three respondents replied that "specifications," "documentation," and "customization" were very closely related. Two respondents did indicate that for "unit cost" discrete dollar amounts should be used for the scaling levels. Another related that, overall, the one through five scales are

perhaps too thin which make it difficult to distinguish between the various levels.

"Criticality" was another attribute that raised some concern. One indicated that it is a dependent variable very heavily influenced by the situation. Another felt it was mostly connected with inventory management rather than the good itself.

b. Additions and/or Deletion of Characteristics

In regards to adding or deleting characteristics, three reviewers indicated that no additional changes were needed. Several, however, felt that there were other characteristics that could be considered. None were listed and scored on the matrix. Rather, they were included as responses to question two leaving the researcher with little information on how the reviewers felt they should be scaled. These additional attributes are listed in Table 3-6 with none cited by more than one reviewer.

TABLE 3-6

Additional Characteristics To Consider
Source: Researcher's Analysis

* Reliability
* Life cycle
* Availability
* Technical support
* Seller installation requirements
* Versatility
* Adaptability
* Safety

c. Important Physical Characteristics

The reviewers supplied many physical characteristics that could be considered in a strategic classification. Table 3-7 lists these characteristics along with the frequency cited.

TABLE 3-7

Physical Characteristics
Source: Researcher's Analysis

Characteristic	Frequency Cited
Weight	4
Shipping & handling considerations	4
Toxicity/volatility	3

d. Other Concerns with the Approach or Model

One reviewer suggested that a brief description of the good's function would be appropriate and help eliminate confusion. Related to this comment, two others replied that the questionnaire assumed the reviewer was knowledgeable about all the goods. Both felt that the respondents should be screened prior to completing the matrix to determine if they had ever purchased or used the good.

e. General Comments

Regarding general concerns, a reviewer replied that:

> [It] seems to me that there is considerable room for subjectivity in determining the numerical weights and the choice of the three most important characteristics and priority. In making a purchase, the buyer must consider all the characteristics as each affects the buy.

Another felt that the matrix was too complex to expect a respondent to complete and return in a timely fashion.

F. REVISION OF THE MODEL

Based on the comments and suggestions made by the pre-test group, several changes were made to the model. The complexity characteristic was split into two separate attributes; "rate of technological change" and "technical complexity."

"Maintainability" was redefined to refer to just the frequency of maintenance required for the good. "Stability" was modified to allude to the nature of the requirement only rather than both it and the item design. "Stability" of the

item design is now covered under the characteristic "rate of technological change."

The "specification" characteristic was eliminated from the model because of the overlap with "documentation" and "customization." The option to add characteristics to the matrix, blocks 13-16, was also removed from the model. Because none of the reviewers had used this option and to maintain consistency for data collection purposes, the researcher decided to eliminate this choice.

The researcher also made the determination to limit the number of characteristics to 12 and not add any of the attributes cited by the pre-test group in Tables 3-6 and 3-7. Although many of these properties have strategic value, they should perhaps be subjected to further scrutiny before being used for classification purposes.

The final 12 attributes the researcher settled upon had, to that point, been reviewed by two different groups. First, the expert panel had reviewed and commented on them. Second, the pre-test group had applied the definitions and scales to goods which did reveal several flaws and weaknesses. Introducing new attributes at this stage of the process would be without the benefit of such a detailed analysis. Given the time remaining to complete the study, further iterations to define the characteristics were not practical.

No other changes were made to the matrix, definitions, or scales. The researcher felt that the modifications made to

this point put the model in the best position to be understood by the general respondent. The revised model used for data collection can be found in Appendix B.

G. SUMMARY

This chapter has focused on the goods classification characteristics and how they were structured into a workable scheme. By using an iterative process, the researcher determined the characteristics, definitions, and structure to use in classifying Government goods.

In the next chapter, discussion will center on how the model was used to collect the data and an examination of these data using cluster analysis. The results demonstrate the categorization of the 21 individual goods used in this study into homogeneous groups.

IV. DATA COLLECTION AND PRELIMINARY ANALYSIS

A. INTRODUCTION

In this chapter, the researcher will explain how the data collection model consisting of the grid, characteristic definitions, and scales was used to gather data. Next, an "a priori" classification of the Government goods is presented that provides a benchmark to judge the cluster analysis results. The chapter concludes with a discussion of two clustering methods, selection of the number of categories in which to group the goods, and determination of the method to use in additional clustering iterations.

B. DATA COLLECTION

The data collection model consisting of the grid, attribute definitions, and associated scales was sent to 139 individuals mostly consisting of National Contract Management Association (NCMA) Fellows.

1. Selection of the Scorers

The vast majority of these individuals were selected at random from the 1989-1990 NCMA Fellows Directory. The researcher felt that by virtue of their fellow-status that, as a group, they represented a pool of vast and in-depth contracting knowledge. NCMA fellows are individuals who have been recognized for their contributions in the field of

Government contracting and meet certain eligibility qualifications. (NCMA Fellows Directory, 1990)

Of the 139 selected to question, approximately nine percent represented people other than NCMA fellows. These individuals were chosen based on referrals given to the researcher by various respondents. Even though not members of the select group of NCMA fellows, they still had considerable contracting background in Government acquisition, procurement management, and academia.

Each member of the targeted group was requested to complete the matrix by scoring each good in relation to the characteristics. Survey participants were asked to place a number from one to five in each cell to quantify the relationship between the good and the attribute. Scorers had the option to mark a cell "NA" (Not Applicable) if they felt the characteristic did not apply to the good. Respondents were also asked for a priority ranking of the three most important characteristics from the buyer's perspective for each good. Finally, any comments the scorers may have were also solicited.

2. Survey Response Statistics

At the outset of the survey process, the researcher felt that at least 50 completed matrices would be needed to adequately test the model. Besides any statistical inferences

this number has, having the grid put through the scoring process this many times would be a good test of its feasibility.

Of the 139 individuals queried, 65 responses were received. With 11 of these responses negative, 54 or approximately a 40% positive response rate was achieved.

It is important to note that to achieve this 40% positive rate, the researcher had to take an active role in the survey process. Through follow-up telephone calls to the non-responsive survey participants, the researcher confirmed receipt of the questionnaire and the participant's understanding of how to complete it.

During the follow-up process, the researcher noted that many of the negative respondents said they were unfamiliar with the goods and did not know how they related to the characteristics. This was the most frequently cited reason for not completing the matrix. Even though these individuals were involved in Government contracting, the respondents indicated that their sub-specialty areas in legal or procurement policy, for example, did not provide them with a broad enough base on which to assess the various goods. The second most cited reason for a negative response was a lack of time to score the goods.

C. AN "A Priori" MODEL

Before attempting any cluster analysis, the researcher constructed an "a priori" model for the 21 goods listed in the matrix. This model, shown in Table 4-1, segregates the goods into various categories based on the solution the researcher expected to achieve. The purpose for doing this was to provide an objective benchmark with which to compare the clustering results (Romesburg, 1984, p. 258).

To decide upon the number of categories and the categories in which to place the goods, Miracle's product classification scheme was used as the starting point for the determination. As mentioned in Chapter I of this thesis, Miracle used Groups I-V to categorize products consumers buy. For this study, the researcher concluded that five categories would also be appropriate for one major reason: the unique nature of this scheme.

To the researcher's knowledge, no other scheme exists to classify Government goods on the basis of strategic insight. Therefore, the decision was made at the outset of this effort to keep the scheme as simple as possible yet be informative. Categorizing goods into five groups on the basis of the characteristics chosen, should satisfy these two criteria.

Since the choice of goods was based somewhat on the example products Miracle provided for his five groups, the placement of the Government goods into the appropriate group also patterned Miracle's categorization (Miracle, 1965, p.20).

TABLE 4-1

"A Priori" Classification of 21 Sample Government Goods
Source: Researcher's Analysis

Category 1	**Category 2**
- Salad dressing	- Filing cabinet
- Flat washers	- Pneumatic tire
- Paper towel dispenser	- Fluorescent light tube
- Sandpaper	- 16MM film projector
Category 3	**Category 4**
- Pneumatic chisel	- Microcomputer
- Micrometer	- Semi-conductor assembly
- Shipboard washing machine	- Submarine periscope
- Fork lift truck	- Floating drydock
- Cold food counter	
Category 5	
- Guided missile	
- Fire-control computer	
- Nuclear reactor	
- ECM equipment	

D. PREPARATION FOR CLUSTER ANALYSIS

The researcher's plan was to reduce the group of 54 matrices into two separate matrices. One would consist of the mean values for the individual cells while the other would be a matrix of standard deviation values. The use and purpose of the standard deviation matrix will be discussed in the next chapter of this thesis.

In their present form, the individually completed grids represented three dimensional data consisting of the

respondents, goods, and characteristics. For this research effort, the individual respondents were not critical for the analysis so they were kept anonymous and merely numbered 1 - 54 for record keeping purposes. This resulted in a simplified data reduction process.

1. Computing a Mean Value Matrix

To compute the mean value matrix, the researcher used a computer spreadsheet program to recast the respondent completed grids into 21 separate matrices (one for each good). These matrices related the respondent's code on the vertical axis with the 12 characteristics across the horizontal axis. After subdividing the 54 completed grids in this fashion, they were all recombined into a single matrix by averaging the individual cell scores. The mean value matrix is shown in Table C-1 of Appendix C. The researcher will next demonstrate how this matrix of values will be cluster analyzed to arrive at homogeneous groupings of goods.

2. Background Concerning Cluster Analysis

With a consolidated mean value matrix, the researcher was now ready to begin using cluster analysis techniques to classify the goods into homogeneous groupings.

As mentioned in Chapter II, cluster analysis is one of several methods used in numerical taxonomy. In fact,

Romesburg (1984, p. 30), in discussing its simplicity and straightforward calculations, states that it is the method most often used.

Since cluster analysis is used as a descriptive method for gauging the similarities of objects in a sample, it has been widely applied in various disciplines as a mechanism for constructing classification schemes. (Romesburg, 1984, p. 30)

Psychologists have used cluster analysis to classify individuals by personality types, regional analysts have used it to classify cities based on demographic variables, and market researchers have applied cluster analysis to customers to group them on the basis of buying habits (Dillon, 1984 p. 157). Other examples include meteorologists who utilized cluster analysis to categorize weather types in southern California and medical researchers who used clustering to classify patients with liver diseases (Romesburg, 1984, p.58).

Clustering, in general, follows a series of steps that begins with t clusters, each containing one object, and ends with one cluster containing all the objects. The objective of the cluster analyst is to find out which objects are similar and dissimilar to each other. (Romesburg, 1984, p. 10)

The definition of similar is relative, though, and will depend upon on how finely the analyst wants to segregate the objects. In this research effort, all the objects are similar in that all are considered Government goods. The

researcher will demonstrate that, regardless of the overall similarity, the goods are quite different based on their characteristics.

3. Methods Used in Cluster Analysis

The researcher used two hierarchical clustering methods, average linkage and Ward's minimum variance. The SAS (Statistical Analysis System) program was used to perform the cluster analysis on the mean value matrix. Both of these methods use the hierarchical procedure but differ in how the distance between two clusters is computed (Parker, 1987, p. 284).

The process starts with each object in a cluster by itself and continues until only one cluster is left. Clusters are eliminated by merging the two closest clusters to form a new one that replaces the two previous clusters.

The researcher chose the average linkage and Ward's minimum variance methods because of their popularity among cluster analysts. They are first and second respectively in terms of frequency used. (Romesburg, 1984, pp. 15 and 129)

The average linkage method defines the similarity between any two clusters as the arithmetic average of the similarities between the objects in the one cluster and the objects in the other. Ward's clustering method assigns objects to clusters in a way that minimizes a sum-of-squares index *E*. (Romesburg, 1984, p. 317)

E. INITIAL CLUSTER ANALYSIS RESULTS

The researcher cluster analyzed the 21 goods considering all 12 characteristics. The categories of goods that resulted from each of the two methods at the five cluster level were the same.

1. Comparison Between Clustering Methods and The A Priori Model

Table 4-2 shows a side-by-side comparison of the various groupings that result from using the two different clustering methods. Also shown are the researcher's a priori categories.

Beside each cluster heading for the two clustering methods, is a three-digit number representing the average value of all the attributes for the goods in that group. Upon examination, one can easily see how this value increases from cluster one to five. This increasing average attribute value illustrates the simple to complex spectrum that exists within the sample Government goods.

Both methods produced the same results in terms of the members within each cluster. Intuitively, the five category clustering level appears reasonable given the breakdown of the goods within each cluster.

Concerning the results of the two methods compared to the researcher's a priori model, each made less of a distinction between the more "simple" goods. The goods from

TABLE 4-2

Comparison Between Two Clustering Methods & "A Priori" Model
Source: Researcher's Analysis

Average Linkage	Ward's Min. Variance	"A Priori"
Cluster 1 - 1.33	Cluster 1 - 1.33	Category 1
- Sandpaper	- Sandpaper	- Sandpaper
- Flat washer	- Flat washer	- Flat washer
- Salad Dressing	- Salad dressing	- Salad dressing
- Paper towel dispenser	- Paper towel dispenser	- Paper towel dispenser
- Filing cabinet	- Filing cabinet	
- Fluorescent light tube	- Fluorescent light tube	Category 2
- Tire	- Tire	- Filing cabinet
		- Tire
Cluster 2 - 2.22	Cluster 2 - 2.22	- Fluorescent light tube
- Pneumatic chisel	- Pneumatic chisel	- 16MM film projector
- Film projector	- Film projector	
- Micrometer	- Micrometer	Category 3
- Cold food counter	- Cold food counter	- Pneumatic chisel
- Fork truck	- Fork truck	- Micrometer
- Washing machine	- Washing machine	- Washing machine
		- Fork truck
Cluster 3 - 3.13	Cluster 3 - 3.13	- Cold food counter
- Microcomputer	- Microcomputer	
- Semi-conductor assembly	- Semi-conductor assembly	Category 4
		- Microcomputer
Cluster 4 - 3.29	Cluster 4 - 3.29	- Semi-conductor assembly
- Floating drydock	- Floating drydock	- Floating drydock
		- Periscope
Cluster 5 - 4.25	Cluster 5 - 4.25	
- Periscope	- Periscope	Category 5
- ECM equipment	- ECM equipment	- ECM equipment
- Fire-control computer	- Fire-control computer	- Fire-control computer
- Guided missile	- Guided missile	- Guided missile
- Nuclear reactor	- Nuclear reactor	- Nuclear reactor

the first three categories of the a priori model were grouped into two clusters. At the other end of the spectrum, both methods split categories four and five into three clusters. Therefore, both clustering methods produced a finer differentiation between the goods at the more complex level.

Before continuing with the analysis, the researcher made the decision to use only one clustering method rather than two. Since both clustering methods produced the same results, the researcher decided to use average linkage for future clustering iterations and testing. Because of its popularity among researchers and the reasonable output, it appeared to be the most logical choice.

2. Validation of the Clustering Results

Besides comparison with the researcher's prior expectations there is another method for determining the validity of the clusters. Romesburg (1984, p. 273) proposes splitting the original data matrix and running the cluster analysis on two separate groups of data. For the analysis to be valid, clustering on basis of the two split samples of data should produce similar results as the original data matrix.

For the purposes of this research effort, using this validation process involves constructing two mean value matrices with each based on 27 respondent-completed questionnaires. Using a random number table, the researcher split the original data based on the 54 responses into two

groups of 27. From these two distinct groups two separate mean value matrices were computed and then used as the basis for clustering. Clustering at the five-category level yielded the same results as the original data matrix.

3. Determining the Number of Clusters

There does not appear to be any hard and fast rule for determining the proper number of clusters. Indeed, Parker, (1984, p. 80) as editor of the SAS Guide, states that "there are no satisfactory [analytical] methods for determining the number of population clusters for any type of cluster analysis." Therefore, initially it seemed reasonable given the scaling method employed, to use five as the appropriate number of categories.

This decision was further strengthened when the data were clustered at the four or six category level. With four clusters, the first two groups shown in Table 4-2 were combined while groups two through five remained intact. At the six cluster level, the paper towel dispenser and the filing cabinet were broken out of cluster one and combined into a separate category. No other changes occurred. Since neither of these results compared as favorably with the researcher's prior expectations as did the outcome using five categories, using five clusters appeared to be the best choice.

A final argument for using five clusters is the average distance between the clusters at the five category level. Although there is not any consensus agreement on number of clusters determination, one recommendation is to decide at which cluster level the number of clusters remains constant for the greatest width of range in distance between clusters. (Romesburg, 1984, p.213)

To illustrate this concept, the "tree" or dendrogram that resulted from clustering the orginal data matrix is shown in Figure 4-1. Trees are commonly used in cluster analysis to show the hierarchy of similarities among all pairs of objects (Romesburg, 1984, p. 32). Quite often, cluster analysts refer to this number of clusters dilemma as where to "cut the tree."

For the tree in Figure 4-1, the 21 sample goods are listed across the top. The average distance between the clusters is shown along the side. Since this is a hierarchical presentation, the tree begins with one cluster consisting of 21 goods and eventually branches into 21 clusters each containing one good. Spaces in the tree where there are no "X's" represent a split into another category. As the numbers of clusters increase, the clusters get closer together and less distinguishable.

Cutting the tree at "Cut1" would yield the two groups of goods shown in Table 4-3. The distance over which these two groups remains constant is .575 (1.3-.725). If the tree were cut at "Cut2", the five groups shown in Table 4-2 would

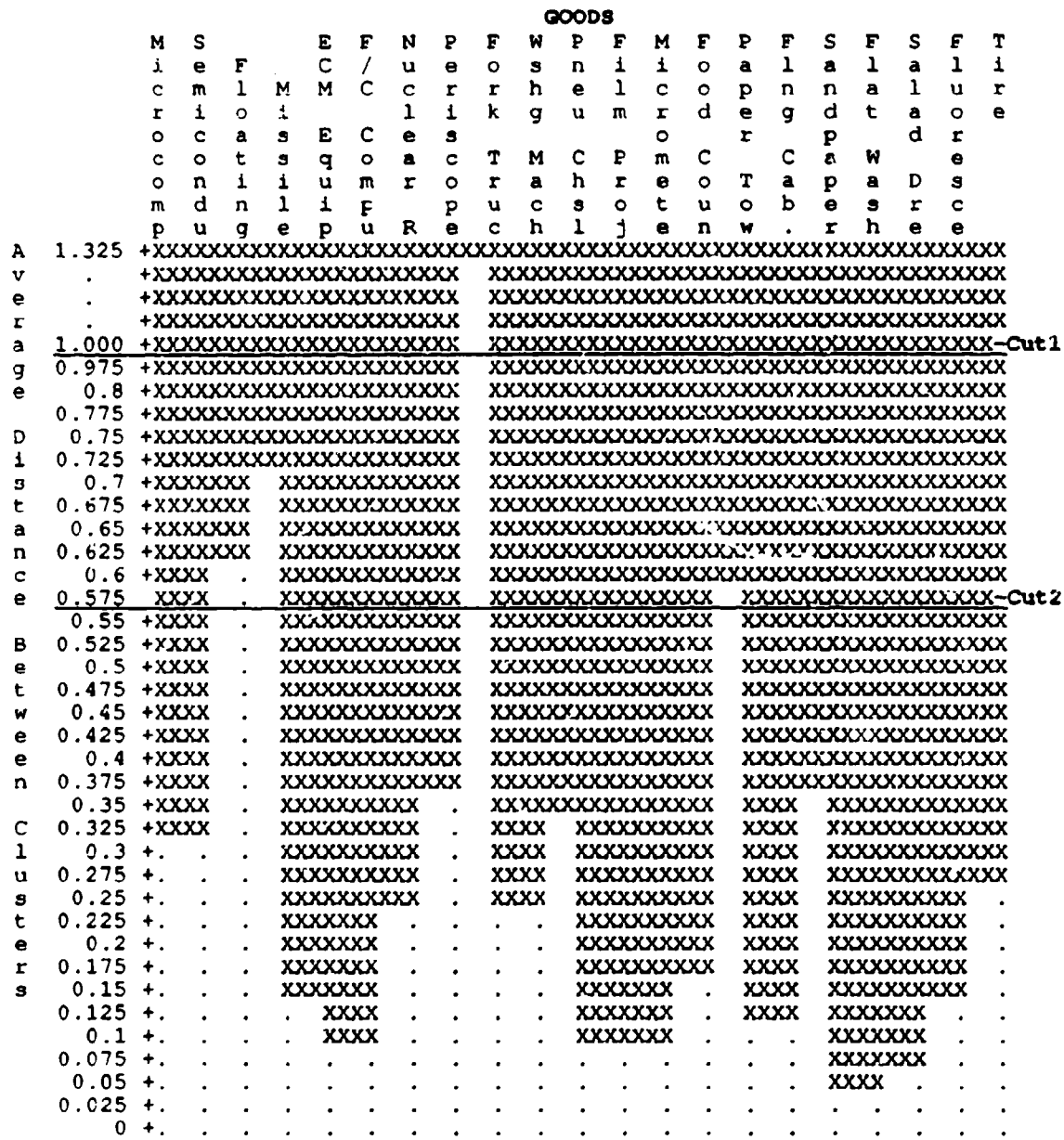

FIGURE 4-1

Tree Resulting From Clustering the Mean Value Matrix
Source: SAS Output

TABLE 4-3

Results of Cutting the Tree At Two Clusters
Source: Researcher's Analysis

Cluster 1	Cluster 2
- Micrcomputer	- Fork truck
- Semiconductor	- Shipboard washing machine
- Floating Drydock	- Pneumatic chisel
- Guided missile	- 16MM film projector
- ECM equipment	- Micrometer
- Fire-control computer	- Cold food counter
- Nuclear reactor	- Paper towel dispenser
- Periscope	- Filing cabinet
	- Sandpaper
	- Flat washer
	- Salad dressing
	- Fluorescent light tube
	- Tire

result. The distance over which these two groups stays constant is .25 (.6-.35). While admittedly this is less than at the two-cluster level, it is still more than the distances for any other number of clusters. Clustering with only two groups would be entirely too general to provide any benefit. Therefore, using five categories also appears to be reasonable given this distance analysis.

F. SUMMARY

In this chapter, the researcher explained how the goods versus characteristics matrix model was used to collect data.

Also discussed was the response rate achieved and the process involved in tabulating a single, mean-value matrix. Using the mean-value matrix, initial cluster analysis results were compared between two clustering methods and the a priori model. Finally, explanation was provided regarding the researcher's decision to use the average linkage method at the five category level in future clustering iterations.

Analysis of the data continues in the next chapter as the researcher uses the average linkage method and other techniques in an attempt to reduce the number of characteristics and simplify the model.

V. SIMPLIFYING THE TAXONOMICAL MODEL

A. INTRODUCTION

One of the objectives of any classification scheme is parsimony. Parsimony in classification means achieving internal homogeneity between the groups of objects with the fewest number of categories and attributes. (Chrisman, 1988, p.417)

In this chapter, the researcher explains the different techniques used to analyze the extent each of the characteristics contributed to the model. From this analysis, conclusions were drawn regarding which attributes to retain in the model. Finally, based on the remaining attributes, appropriate descriptions and average attribute values were developed for each category.

B. ANALYZING THE ATTRIBUTES

The researcher chose to examine the attributes from two different perspectives. First, on a cell-by-cell basis, the range of scores was examined by computing the standard deviation for each cell in the matrix. Next, several sequential listings of the attributes were determined based on the priority rankings the respondents listed in column 13 of their individual matrix responses. Both of these perspectives

were then used by the researcher as the basis for simplifying the classification model.

1. **Standard Deviation Matrix**

Following somewhat the same process used in constructing the mean value matrix, the researcher calculated the standard deviation matrix shown in Table D-1 of Appendix D. This allowed an analysis of the variance in scores and some initial conclusions about some of the characteristics.

From the researcher's perspective, those characteristics that consistently had a high number of goods with standard deviations greater than one indicate some possible interpretational problems. Realizing that the scales are from one to five, any cell with a standard deviation of greater than one represents a 20% variation in application. This, coupled with the fact that none of the cells in the standard deviation matrix had a value greater than two, led the researcher to believe that one was an appropriate point at which to make this distinction.

For those attributes in the high standard deviation category, definitions were perhaps difficult to understand or the scales were perplexing to the scorers. These may be two reasons for the wide variation in scores, hence the consistently higher standard deviation.

After calculating the standard deviation matrix, the researcher examined each attribute individually and tabulated

the number of goods where the standard deviation was greater than one.

Also, a mean standard deviation value was calculated for each characteristic. This measure would provide an additional method to examine the variability in scoring. Even though a characteristic may have had a high variability for one to three goods, the variance in the scoring for the remaining goods could have been fairly low. A mean variability measure would take this situation into account and give an overall indication of scoring variance.

With the mean standard deviation, the researcher then used cluster analysis to cluster the characteristics into groups that exhibited the closest similarity. The results, shown in Table 5-1, clearly show that two characteristics, "homogeneity" and "consumption," are significantly more variable than the other attributes.

For comparison purposes, the number of goods where the standard deviation was greater than one is shown in the second column of Table 5-1. These numbers were not used to determine the three clusters and the results are not entirely consistent with the mean variability values for the first and second cluster. Several attributes in the first cluster exhibited instances where the standard deviation was greater than one for two goods yet their mean values were relatively low.

However, for the third cluster, both methods of addressing variability are in direct relationship. Both the

TABLE 5-1

Clustering the Characteristics by Mean Standard Deviation
Source: Researcher's Analysis

Cluster 1	Mean Standard Deviation	# of Goods Greater Than 1
Documentation	.54	2
Complexity	.57	0
Unit Cost	.59	0
Criticality	.59	1
Change	.61	0
Maintainability	.62	2
Stability	.65	2
Cluster 2		
Item Attention	.75	3
Customization	.79	2
Cluster 3		
Homogeneity	.97	10
Consumption	1.07	12

values for the mean standard deviation and the number of goods greater than one are higher for the two attributes in this cluster than any other characteristics.

Based on the results as shown in Table 5-1, the researcher concluded that "homogeneity" and "consumption" were in a class by themselves regarding definition and scale interpretation difficulties. Such a conclusive distinction could not be made between the remaining ten attributes.

2. **Treatment of the Priority Rankings**

As the second perspective for analyzing the attributes, the researcher next addressed the respondent-

provided priority rankings of the three most important characteristics for each good. First, the number of times each attribute was cited as number one, two, or three for each good was tabulated. Then these per-good figures were combined together in terms of total frequency. Each characteristic was cited as a number one, two, or three priority characteristic.

Tables 5-2 through 5-5 provide a breakdown of the tabulation results.

Table 5-2 provides the ranking of the characteristics based on the total number of times cited as either a number one, two, or three priority characteristic.

TABLE 5-2

Attribute Order Based on Frequency Cited as a Top 3 Priority
Source: Researcher's Analysis

	Attribute	Freq. Count
1.	Unit cost	640
2.	Maintainability	364
3.	Sources	292
4.	Complexity	259
5.	Customization	236
6.	Consumption	216
7.	Homogeneity	177
8.	Item Attention	147
9.	Change	143
10.	Stability	123
11.	Documentation	93
12.	Criticality	67

Tables 5-3 through 5-5 provide the relative ranking of characteristics based on the number of times cited as a number one, number two, or number three priority respectively.

TABLE 5-3

Attribute Order Based on Frequency Cited as a #1 Priority
Source: Researcher's Analysis

	Attribute	Freq. Count
1.	Unit Cost	342
2.	Maintainability	114
3.	Complexity	94
4.	Consumption	91
5.	Change	81
6.	Customization	80
7.	Homogeneity	59
8.	Sources	46
9.	Item Attention	37
10.	Criticality	19
11.	Documentation	13
12.	Stability	6

As Tables 5-2 through 5-5 illustrate, every attribute was cited at least once as a top three priority characteristic.

TABLE 5-4

Attribute Order Based on Frequency Cited as a #2 Priority
Source: Researcher's Analysis

	Attribute	Freq. Count
1.	Unit Cost	160
2.	Maintainability	153
3.	Complexity	109
4.	Sources	98
5.	Consumption	90
6.	Customization	84
7.	Homogeneity	71
8.	Item Attention	56
9.	Documentation	27
10.	Criticality	27
11.	Stability	25
12.	Change	23

TABLE 5-5

Attribute Order Based on Frequency Cited as a #3 Priority
Source: Researcher's Analysis

	Attribute	Freq. Count
1.	Sources	148
2.	Unit cost	138
3.	Maintainability	97
4.	Stability	92
5.	Customization	72
6.	Complexity	56
7.	Documentation	54
8.	Item attention	53
9.	Homogeneity	47
10.	Change	39
11.	Consumption	35
12.	Criticality	21

As a final method for analyzing the priority rankings, the researcher applied numerical weights to the number of counts the characteristics received for first, second, and third. A weighted value ranking of the characteristics resulted from this effort and is shown in Table 5-6.

TABLE 5-6

Attribute Order Based On Total Weighted Score
Source: Researcher's Analysis

	Attributes	Score
1.	Unit Cost	2466
2.	Maintainability	1223
3.	Complexity	909
4.	Sources	820
5.	Customization	796
6.	Consumption	795
7.	Homogeneity	602
8.	Change	552
9.	Item Attention	461
10.	Stability	289
11.	Documentation	252
12.	Criticality	218

This step was taken to increase the visibility of those attributes that received recognition by the respondents, but not enough to be considered an overall "number one." Rather than just recognize those characteristics that received the highest overall scores for each good, this process would ensure a more fair consideration of all the priority rankings.

The researcher arbitrarily chose values of "5", "3", and "2" for the weights that would be applied to the first, second, and third priority counts respectively. Using Tables 5-2 through 5-5 as the source for the top three priority level counts, Table 5-6 shows the ranking of the attributes in terms of weighted scores.

3. Consolidation of the Attribute Analysis Tables

The tables outlining the results of the characteristic clustering and priority ranking analysis were consolidated in Table 5-7. This matrix table is used to compute the frequency with which the characteristics were found to exhibit lower variability in scoring (column labelled 5-1) and also be among the top six in priority rankings (columns labelled 5-2 through 5-6).

Combining the individual tables in such a fashion allowed the researcher the opportunity to decide if any of the attributes consistently "outperformed" the others. Those characteristics in clusters one or two from Table 5-1 received an "X" in column 5-1. When consolidating the individual rank priority tables, the researcher chose to consider only the top six characteristics from each of these tables for two reasons. It still allowed for the inclusion a wide range of attributes (in terms of frequency and weighted value scores) yet demonstrated that certain attributes were consistently at the top of the list.

TABLE 5-7

Consolidation of The Attribute Analysis Tables
Source: Researcher's Analysis

CHARACTERISTICS	VAR 5-1	T 5-2	O 5-3	P 5-4	.. 5-5	6 5-6	T O T
1.Change	X		X				2
2.Complexity	X	X	X	X	X	X	6
3.Customization	X	X	X	X	X	X	6
4.Maintainabililty	X	X	X	X	X	X	6
5.Homogeneity							0
6.Consumption		X	X	X		X	4
7.Unit cost	X	X	X	X	X	X	6
8.Documentation	X						1
9.Item attention	X						1
10.Sources	X	X		X	X	X	5
11.Criticality	X						1
12.Stability	X				X		2

C. STREAMLINING THE MODEL

This section describes the process the researcher used to simplify the model. While using 12 characteristics is a comprehensive approach to classifying the goods, it is likely that not all contribute to the same degree in the categorization of the goods.

The researcher's goal at the outset of the simplification process was to attempt to reduce the 12 characteristics but keep those that were significant to the definition of the categories. A characteristic would not be removed from the model if its absence resulted in dramatically different clustering outcomes at the five-category level. For example,

if clustering without "complexity" caused the nuclear reactor to group with sandpaper then "complexity" would not be removed.

1. Basis for Attribute Removal

One method that has been recommended for determining the contributing characteristics is to compare their means across the various clusters. An attribute that greatly influences the clustering is one that shows a large difference in mean value, relative to the standard deviation, across two or more clusters. On the other hand, an attribute whose mean is about the same across the clusters may be nonessential. (Romesburg, 1984, p. 273)

The mean attribute and standard deviation values for the twelve characteristics were computed for each of the five clusters. The results, shown in Table 5-8, formed the basis for determining which characteristics to remove from the model. Attributes with the lowest range in mean value would be selected first as the primary candidates for removal. After temporarily removing a characteristic, the clustering program was to determine the outcome. If no changes occurred in the five categories' constituent objects, the characteristic would be eliminated from the model. The process would continue one attribute at a time until the point was reached when the goods began to migrate to other categories.

TABLE 5-8

Average Attribute Value Per Cluster
Source: Researcher's Analysis

CLUSTER	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12
1	1.21	1.21	1.27	1.19	1.47	2.34	1.21	1.11	1.23	1.40	1.22	1.16
2	75	2.04	1.90	2.20	2.15	3.85	2.28	2.11	2.37	2.40	1.78	1.83
3	4.29	3.91	2.91	2.75	2.93	3.62	2.99	3.11	2.87	2.60	2.67	2.99
4	1.85	2.52	3.17	3.04	3.35	4.40	4.17	3.37	4.21	3.54	2.92	2.96
5	4.14	4.52	4.65	4.23	4.38	4.07	4.61	4.74	4.18	3.67	3.92	3.85
Range	2.93	3.31	3.38	3.03	2.90	1.73	3.40	3.63	2.95	2.27	2.70	2.69

CLUSTER	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12
1	0.21	0.20	0.13	0.22	0.14	1.04	0.30	0.13	0.17	0.28	0.25	0.16
2	0.10	0.22	0.58	0.47	0.30	0.26	0.47	0.37	0.34	0.27	0.28	0.30
3	0.09	0.13	1.02	0.16	0.66	0.33	0.07	0.05	0.04	0.40	0.50	0.13
4*	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5	0.58	0.53	0.17	0.45	0.13	0.42	0.31	0.28	0.38	0.11	0.18	0.32

* Since only one good, floating drydock, clustered in group 4, a standard deviation value could not be computed.

C1 - Change
C2 - Complexity
C3 - Customization
C4 - Maintainability
C5 - Homogeneity
C6 - Consumption
C7 - Unit Cost
C8 - Documentation
C9 - Item Attention
C10 - Sources
C11 - Criticality
C12 - Stability

2. Characteristics Chosen for Removal

The first characteristic chosen for removal was "consumption". This decision, while based primarily on its low variation in mean value across the five clusters, also had to do with its high variability in scoring. Referring to Table 5-1, this attribute exhibited both a high frequency and high degree of scoring variability.

Concerning "consumption's" higher standard deviation, the researcher noted that some of the respondents probably misinterpreted the scales. Several of the returned questionnaires had instances where the goods that were consistently scored "1" or "2" for 11 of the characteristics had a "5" for "consumption." Rarely, in these instances, were the consumption values any other than "5." To the researcher, this indicated an opposite interpretation of the scale than that intended.

Even though "consumption" placed high among the other characteristics in terms of priority ranking, the degree of variation in the scores and some of the comments indicated interpretational problems. One respondent wrote "consumption doesn't seem to fit in [the] group [of characteristics]" while another related that "consumption is battle status sensitive." The results of dropping this characteristic had no affect on which goods were in which categories.

The second attribute removed was "sources." Again, this attribute was regularly cited by the respondents as a

priority characteristic (Table 5-7), yet its low range in scores indicate that it did little to differentiate the goods. While undoubtedly an important consideration for a buyer, it may not be that critical for classification purposes. With the removal of "sources" there were 10 remaining attributes. Clustering with these 10 attributes yielded the same outcome as with the original 12.

The next characteristic targeted for removal was "homogeneity." It, like "consumption," exhibited interpretational difficulties given the high degree and frequency in scoring variability. Also, as shown in Table 5-8, there was a relatively low change in the mean value of the characteristic. Now, with nine attributes, cluster analysis verified again that the constituent goods remained the same.

The same basic process, removal based on narrow range in mean attribute value and cluster analysis verification, was used for three additional attributes. These characteristics were, in order of removal, "stability," "criticality," and "change." Now, with only six attributes remaining in model, the clustering results were still the same as the original outcome. The same goods grouped together.

The six remaining attributes were "complexity," "customization," "maintainability," "unit cost," "documentation" and "item attention." The researcher validated these results using the two separate matrices based

on the split respondent groupings. One produced exactly the same outcome as that based on the original data matrix. The other was different only in that the periscope migrated into the fourth cluster with the floating drydock.

Given these near identical results, the researcher felt that using these six attributes was a reasonable approach to classifying the goods. It is interesting to note that four of these six characteristics were the "best" in terms of their low variability in scores and their frequency cited as a priority characteristic. Table 5-7 illustrates this point as the counts shown in the total column are the among the highest for these four attributes.

Certainly in terms of simplicity the model would now be more practical to use. Many of the respondents had indicated that using 12 attributes had made completion of the questionnaire an arduous task. Reducing this number by 50% should ease the burden of assessing a good, yet, as indicated by the results shown here, still provide a logical classification of goods. With the six remaining attributes, the researcher summarized the average values per characteristic per category in Table 5-9.

TABLE 5-9

Average Categorical Values for the 21 Sample Goods
Source: Researcher's Analysis

Attributes	Categories				
	1	2	3	4	5
Complexity	1.21	2.04	3.91	2.52	4.52
Customization	1.27	1.90	2.91	3.17	4.65
Maintainability	1.19	2.20	2.75	3.04	4.23
Unit cost	1.21	2.28	2.99	4.17	4.61
Documentation	1.11	2.11	3.11	3.37	4.47
Item Attention	1.23	2.37	2.87	4.21	4.18
Number of Goods	7	6	2	1	5
Categorical Mean	1.20	2.15	3.09	3.41	4.49
Range in Mean Good Scores	.50	.81	.33	0	.80

As one can see in Table 5-9, the five categories are not equally distributed along the spectrum. For the sample goods, the first two categories encompassed a wider range of average attribute values. For those goods in the first category, the average values for the six attributes ranged from 1.05 to 1.55 for a difference of .50. The mean good score for the first category was 1.20.

For the second category, the range of average scores was even greater at .81. The mean for this group was 2.15. Since only one good, the floating drydock, ended up in the fourth category, there was no categorical range value.

Because a more equal dispersion was not achieved one may conclude that the selection of goods was not adequately diversified. Another reason may be that the sample size was too small to provide an adequate representation of the population. Also, the subjectivity involved in applying the attribute scales may be another cause of the varying ranges of the average good scores within the five categories.

As it stands, cluster analysis did produce five separate categories of the 21 sample goods. Also by using cluster analysis, the researcher was able to reduce the number of characteristics to a more workable number. However, using the structure, as suggested by the results of classifying these sample goods, may not result in the most appropriate means for categorizing the population of Government goods.

Cluster analysis by its nature is subjective and, as Romesburg states:

> Any conclusions the researcher ascribes to a larger population from which the sample was obtained must be based on analogy, not on inferential statistics . . . [t]hus we must rely on informed judgement to assess the risk of extrapolating similarity relations found in the tree to a more general domain. (Romesburg 1984, p. 30)

Regardless of the outcome of the clustering process, the overall objective of this research effort is to develop a taxonomical structure that lends itself to the entire population of Government goods. Therefore some modifications were made to the cluster analysis results to arrive at a more usable scheme.

D. RESULTANT CLASSIFICATORY SCHEME

The suggested classification scheme is shown in Figure 5-1. This scheme incorporates most of the properties suggested by the cluster analysis with some slight modifications. The various aspects of the scheme are discussed further in this section.

Good: N =

	Avg Value	Categories: Simple (1.00-1.80)	Basic (1.81-2.60)	Moderate (2.61-3.40)	Advanced (3.41-4.20)	Complex (4.21-5.00)
Complexity						
Customization						
Maintainability						
Unit Cost						
Documentation						
Item Attention						
Overall Score						

KEY:
+ : UPPER END OF THE CATEGORY
0 : MIDDLE OF THE CATEGORY
- : LOWER END OF THE CATEGORY

FIGURE 5-1
Individual Good Classification Scheme
Source: Researcher's Analysis

1. Categorical Ranges

The major change made to the structure as suggested by the clustering process was in the ranges of scores for each category. These ranges or boundaries within which the categorical values would fall were relaxed somewhat and made even across the spectrum. The reason for using even width ranges for each category was that the resultant clustering structure was relative to the number of respondents and the number and types of goods.

Also because of the subjectivity involved in scoring the goods, the boundaries for the various categories are not clear-cut except for the most extreme cases. Inferring the same exact structure as derived through cluster analysis on the population of Government goods would appear to be too restrictive.

For these reasons, the range for each category was set at .80. This value was computed by dividing the number of categories (five) by the number of boundaries between the categories (four). This range applies to the values derived for each of the six characteristics and the good's overall score.

2. Categorical Labels

Labels, rather than numbers, were assigned to the five categories to enhance the scheme's ability to convey the meaning of the categories. A number does distinguish between

the categories but tells little else about the features of the category. Even though a person may not recall how each of the attributes vary across the groups, an appropriate descriptive label will summarize the basic properties of the category.

Since this research effort has been based on classifying goods from a simple to complex spectrum, categories one and five were labelled as such respectively. The middle group was labelled "Moderate" because the characteristic descriptions were all of the medium nature.

Group two was labelled "Basic" to indicate the transition from a simple item to one that is more involved in terms of the attributes. The "Advanced" category label is applied to the fourth group to indicate that constituent objects are increasingly more complicated than the "Moderate" group. They are, however, distinct from the fifth category because their degree of complexity is lower.

3. Using the Classification Scheme

The classification mechanism, shown as the grid in Figure 5-1, is the final tool to use in the classification process. Along with the characteristic definitions, scales, and data collection and reduction methods, this scheme constitutes the researcher's proposed method for classifying Government goods.

Beginning with the six attributes, their definitions and scales, the classification process could begin with a survey similar to the one conducted for this research effort. Respondents could first score a good or goods in relation to the six characteristics. Next the data could be averaged to come up with a singular value for each attribute for each good.

Finally, the grid in Figure 5-1 could then be used as the mechanism to display for each good the average scoring values and classify the good into a particular category. Numeric values would be listed in the "Avg Value" column and a "+," "0," or "-" could be used in each of the characteristic versus category cells.

A "+" would be used to symbolize a score that tended to fall near the upper end of a category, "0" near the middle, and "-" towards the lower end. The reason for using these symbols rather than numbers is to enhance the model's capability to show the degree to which the good exhibits certain characteristics.

All of the components of the taxonomical model consisting of the data collection tool, characteristic definitions and scales, and the classification scheme are consolidated together in Appendix E.

Using the revised classification scheme, the researcher has categorized each of the 21 sample goods. In using this approach, only two goods, the fork lift truck and

the periscope, ended up in different categories then when categorized via cluster analysis. The difference was subtle. Instead of a category 2 good under cluster analysis, the fork lift truck is barely a "Moderate" (category 3) item. For the periscope, it falls in the high end of the "Advanced" category rather than group with the other complex goods. The results for the remaining goods are provided in Appendix F.

4. Benefits from Using the Proposed Taxonomy

Throughout this thesis, the researcher constantly looked for potential benefits from classifying goods strategically. One of the major benefits could be in the staffing function of a procurement organization. Several members of both the expert panel and the scoring group indicated that the scheme could be used to correlate the characteristic level of the goods with a buyer's capability.

One respondent related that the scheme may have value in segregating goods within commodity type. Too often, manpower requirements at the base contracting level are based on commodity type with little consideration given to the wide range of differences between the goods within a particular commodity. This individual used the example of where the requirement for computers were all treated alike. There was no latitude for recognizing those buys that were highly technical and incorporated many of the characteristics described in this research.

Another potential benefit from using such a classification scheme could possibly be in the area of contracting laws, regulations, and procedures. After classifying enough goods, patterns or trends may result that will allow for additional streamlining of the policies and procedures for certain categories. Whereas before, the distinction was based more on commodity type, now the perspective would be broader and ensure consideration of more goods.

This breakthrough may lead to another advantage and that is increased use of commercial products. Within the expert panel group, several members felt the Government must rely less on development items and more on commercially-available goods. This scheme, as structured, may highlight more goods that could be purchased commercially. By more closely identifying a good's characteristics, commercial substitutes to Government development may be more apparent.

E. SUMMARY

This chapter has detailed the results of the researcher's efforts to streamline the taxonomical model and derive a classification scheme. The simplification process began by first analyzing the characteristics in terms of the priority rankings and variability of the scores. Next, by using cluster analysis, the number of characteristics were reduced

to come up with those that contributed the most to the goods classification scheme.

After the appropriate categories and characteristics were decided upon, categorical ranges, and labels were applied to each of the five groups. Also offered was a proposed mechanism for classifying the population of Government goods into specific categories. The chapter concluded with a discussion on some of the potential benefits from using the goods taxonomy.

The next chapter will highlight the conclusions determined from this study and also provide recommendations for further research efforts.

VI. CONCLUSIONS AND RECOMMENDATIONS

A. INTRODUCTION

This chapter will offer conclusions and recommendations based on the research and answer the primary and subsidiary research questions. The chapter will conclude with recommendations for areas of further research.

B. CONCLUSIONS

Several conclusions can be drawn from the research conducted in this study.

1. It is possible to classify goods by characteristics other than commodity type.

At the outset of this study, the researcher's goal was to develop a classification scheme that offered strategic insight. Classifications, such as the Federal Supply Class system, based on commodity type fail to segregate goods in such a manner.

While the characteristics selected in this study may be more difficult to precisely assess, they do differentiate and distinguish between various types of Government goods.

2. The six characteristics which resulted from this study were complexity, customization, maintainability, unit cost, documentation and item attention.

Classifying the sample Government goods demonstrated that three intermediate categories of goods exist between the

polar ends of the spectrum. In some cases, the boundaries between the categories were not clearly drawn. Yet, there remained sufficient difference between the goods to allow for distinction between the five classes.

3. **Cluster analysis is a useful approach for constructing a classification system for Government goods.**

Researchers should be aware that cluster analysis is not an exact tool that will always lead to conclusive results. This fact, however, can be one of the major advantages of clustering. Because of the subjectivity that is built into the clustering process, it is adaptable to many different types of classification applications.

For this research effort, cluster analysis provided the framework on which the classification scheme was developed. Cluster analysis techniques were used to categorize the 21 sample goods into five groups of goods that exhibited similar characteristics. In addition, clustering was the mechanism by which non-essential attributes were eliminated leading to a simplified model.

4. **Any classification scheme developed for the purposes of categorizing commodities will be subjective in nature.**

The subjectivity of the researcher's scheme lies mostly in the application of the scales. Quantifying a qualitative characteristic does not remove the subjectivity from the classification process. However, the subjective nature of an attribute should not prevent its consideration.

Quantifying the attributes does allow for a relatively straightforward process of categorizing various objects into groupings of similar objects.

The burden, when using a scheme, is placed on the scorer or reviewer to be as objective as possible in order to produce meaningful results. The scorer's knowledge of the good and experience in its acquisition will significantly enhance the results of the classification process.

5. **Various methods can be used in developing a classification scheme.**

The model as proposed is based on the results from categorizing 21 sample goods. More rigorous and thorough testing is needed before it can be expected to produce convincing results.

Additionally, the basis upon which it was formulated and the methodology used in its development are certainly not the only ways in which a taxonomy can be generated. Categorizing goods on a basis of common to unique, while similar in many respects to this study, may offer different insights.

C. RECOMMENDATIONS

As a result of this study, the researcher developed several recommendations.

1 **The model developed as a result of this research should be established as a proposed taxonomy for classifying goods.**

This research has demonstrated the capability to classify goods into five different categories using characteristics other than commodity type. The implications from using the proposed scheme warrant its consideration as a strategic model for analyzing Government goods.

Classifying goods based on their degree or complexity, customization, maintainability and so forth may provide a user with additional insight about the relationship between a good and the way it is or should be purchased. This could lead to the refinement of procurement policy, better means to staff and direct procurement organizations, and improved training and education of the acquisition workforce.

2. **The model should be thoroughly tested using various types of sample goods.**

In constructing the proposed scheme, the researcher consciously chose a group of heterogeneous goods. Such an approach should continue in order to accurately represent the population of Government goods. However, the opposite approach could also be taken where application of the model is focused on a group of relatively homogeneous goods. This tactic may reveal weaknesses in the model that the divergent approach would not.

3. **Future research efforts should continue to examine and reveal those characteristics of goods that impact the buying process.**

The characteristics by which objects are classified determine the resultant taxonomical structure. The

determination of the characteristics is probably the key step in the classification process. Therefore, additional research and study is needed in this area to reveal any other crucial characteristics.

Several characteristics were eliminated early on in this study that accurately describe goods. Their inclusion could have resulted in a rather different classification structure. Likewise, several characteristics were included in the model, that later, during the analysis of the data, were found to contribute less to the distinction of goods than others. Only through rigorous and repetitive testing will an accurate assessment of the most appropriate characteristics be possible.

4. **Impose or develop a model on a subset of goods rather than the entire population.**

A final recommendation is to focus classification efforts on a smaller group of goods. This research effort identified the goods the Federal Government buys as the population. In retrospect, this approach may have been too broad and encompassing. For example, even to choose a sample of goods that adequately represents the population was difficult. A more manageable process may be to analyze those goods within a certain commodity type that exhibit a wide range of characteristics. Another would be to look only at those goods procured by a single organization that buys a wide variety of goods.

D. RESEARCH QUESTIONS

This section provides responses to the research questions posed in Chapter I.

The primary research question this thesis attempted to answer was:

What would be the essential characteristics or features of a taxonomical structure that would classify the goods purchased by the Federal Government?

The essential features of the proposed taxonomical structure begin with the basis on which the scheme was developed. Next would be the describing characteristics and their definitions. The final element of the structure would be the classification scheme that allows for the categorization of the goods.

Subsidiary research questions included:

1. **What steps or procedures should be considered in developing a classification scheme for Government purchased goods?**

As the first step of the classification development, a purpose or reason for classifying goods must be established. Then, based on the purpose, the most appropriate characteristics or attributes of the goods can be determined. The nature of these characteristics should be such that they allow for accomplishment of the purpose. Next, a systemized methodology for comparing the goods with the characteristics must be employed. As the fourth step, based on the results of the comparison efforts, categories of goods that exhibit the

most similarity should be determined. Finally, any resultant scheme should be tested to ensure it meets its original purpose.

2. **What are some of the distinguishable characteristics of the goods procured by the Federal Government?**

From a preliminary listing of 22 characteristics, 12 were chosen and applied to the sample goods. These characteristics were complexity, change, customization, maintainability, homogeneity, consumption, unit cost, item attention, documentation, sources, criticality and stability. While not all of these are inherent to Government goods, their relationship is so close to the type of good that it does distinguish the goods into two or more categories. Except for a few occurrences, the respondents were able to determine the degree of attribute presence for each of the sample goods.

3. **Which properties or characteristics of the goods are the most important for classification purposes?**

As suggested by this research effort, six attributes defined and segregated the 21 sample goods into five categories. These attributes included, complexity, customization, maintainability, unit cost, item attention and documentation. While sufficient for distinguishing this sample, further testing of their appropriateness is necessary.

4. **What should be the decision criteria for classifying Government purchased goods?**

For this study, the decision criteria or purpose for classifying Government goods was to identify their differences

in a way that offers the most strategic insight. This was achieved by developing a scheme that allows for classification of the goods across the spectrum from simple to complex. Other methods, or bases, for classification exist that quite likely can achieve the same goal.

5. **What are the various homogenous categories of goods procured by the Government?**

The researcher was able to identify five categories of goods that exhibited relatively different characteristics. These categories consisted of "Simple," "Basic," "Moderate," "Advanced" and "Complex." The argument can be made that these five groups are not entirely homogenous. Certainly, based on the sample goods, a clear distinction was not present between the moderate and advanced categories. Overall, however, the differences exhibited by the goods allowed for a determination that some separation between the goods did exist.

6. **In what areas of Government procurement will this classification scheme be useful?**

Based on responses from survey participants, the greatest utility from such a scheme lies in managing a buying organization. Specifically, areas such as staffing and organizing buying functions would benefit the most from the proposed scheme. If a sufficient number of goods are categorized, secondary benefits may occur in areas of managing the buying process.

7. **What would a taxonomical structure for classifying Government goods consist of?**

The structure that resulted from this research effort would involve three essential elements. First would be the six attributes along with their definitions and scales. The next element would be the goods versus attributes scoring matrix. From this matrix, a good could be classified into one of the five categories by using the classification scheme.

E. RECOMMENDATIONS FOR FURTHER RESEARCH

The following recommendations are made to continue the contracting subject matter classification efforts.

1. **Test the model by applying it to a particular buying organization's range of goods purchased.**

This approach could be used on an organization that buys a relatively homogenous group and also those that purchase a wide variety of goods. The results could be compared to highlight any deficiencies or changes needed to the model. Before requesting a reviewer to score any goods, a suggestion is to pre-screen the respondents to validate their feedback. This could consist of a simple, 2-3 question questionnaire to determine their qualifications.

2. **Use essentially the same classification approach but try other characteristics.**

As was indicated throughout this study, several other characteristics exist that could be used to classify goods.

Characteristics more closely associated with the environment and buying process were recognized but not included as a part of the scheme.

Also, there are physical characteristics of goods that are important from the buyer's perspective. Some of these like perishability, durability, and weight lend themselves to a scaling analysis similar to the one used in this study. Consideration of additional attributes may result in more enlightening results about the relationship between Government goods.

2. **Use an entirely different methodology to construct a classification scheme.**

The scheme proposed in this study was based primarily on the results from cluster analysis. As a type of grouping technique, cluster analysis is only one of several methods that can be used to construct classification systems. A recommendation would be to determine if it is possible to obtain some type of expert agreement on what an "a priori" model would be. Possibly through the use of delphi techniques, characteristics and ultimately the structure could be developed. Results from this expert opinion model could then be compared with the scheme from this study.

3. **Develop a scheme to classify services that the Government buys.**

To scope this thesis, services were purposely omitted. However, given the amount and various types of services the Government purchases, they are a viable group that could be

segregated into categories. One possible strategy would be to analyze the services on a routine to complex basis.

Researchers within the marketing discipline have recently begun to recognize the need to classify services. While the research has not been as extensive as that associated with goods, several perspectives for classifying commercial services do exist. Some of these possible taxonomical approaches may be appropriate for application to the public sector.

F. SUMMARY

This chapter presented conclusions and recommendations from the research. It also provided answers to the primary and subsidiary research questions. The chapter concluded with recommendations for areas of further research.

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APPENDIX A

List of Expert Panel Members

Coates, Elinor Sue, Instructor & Consultant, Golden Gate University/St. Mary's College, San Francisco, California

Garrett, Gregory A., CAPT, USAF, Assistant Professor of Contracting, Air Force Institute of Technology, Wright-Patterson AFB, Dayton, Ohio

Haugh, Leroy, Vice-President, Aerospace Industry Association (AIA), Mclean, Virginia

Hearn, Emmett, Instructor, University of California, Berkeley, California

Jarrett, Charles E., President, JAYCOR, San Diego, California

Lessig, James B., Vice-President, Logistics Management Institute (LMI), National President, National Contract Management Association (NCMA), Bethesda, Maryland

Macfarlan, W. Gregor, Vice-President, Harbridge House, Inc., Arlington, Virginia

Meneely, Frank T., Professor, Defense Systems Management College, Fairfax, Virginia

Raisters, Alfred, Ph.D., Professor, UCLA, Los Angeles, California

Sapp, Richard, Ph.D., Vice-president for Product Assurance, Lockheed Corporation, Solvang, California

Sowle, Donald E., Former Director of the Office of Federal Procurement Policy (OFPP), McLean, Virginia

Trimble, Robert, Former Vice-President of Contracts, Martin-Marietta Corporation, Gaithersburg, Maryland

Zemansky, Stanley D., Retired Director of Purchasing for Baltimore, Baltimore, Maryland

SMC #2023
Naval Postgraduate School
Monterey, CA 93940

Dear _____,

My name is LT Brian Wenger and I am a student at the Naval Postgraduate School in Monterey, California. I am using an expert-panel approach to researching my thesis, and I would like to solicit your views on classifying Government goods.

My thesis is entitled "A Taxonomical Structure for Classifying Goods Purchased by the Federal Government". My objective is to develop a scheme for classifying goods on a basis that offers the best strategic insights. In other words, which characteristics of the goods, acquisition process, and the procurement environment provide the most information for the purposes of defining contracting policies and methods? Enclosure (1) provides additional information about the potential uses of this scheme along with some necessary principles for classification systems.

One of the important steps in developing a classification structure is the generation of the characteristics by which the objects are judged. This is where I need your help. I would like your feedback on my approach to classifying Government goods and, if you agree with it, which characteristics are the most significant.

Therefore, I would like to call you during the week of 30 July and arrange for a convenient time to conduct a telephone interview. During the interview, I would like to ask the questions listed in enclosure (2). The questions are aimed at defining those characteristics which most clearly differentiate goods into homogeneous categories.

I have listed the attributes the characteristics must possess in enclosure (3) along with several preliminary characteristics. These are based on my literature research and qualitative judgement and are by no means exhaustive. I would like to discuss these characteristics further with you to narrow or add to the list as appropriate. Ultimately, I would like to end up with a workable number of characteristics of about 10-15.

Your extensive contracting background and knowledge (evidenced by your high standing as an NCMA Fellow) will be invaluable to

me as I develop my ideas into a workable classification structure. I look forward to talking with you.

Sincerely,

Brian L. Wenger
LT, SC, USN

3 Encl.

GOVERNMENT GOODS CLASSIFICATION SCHEME

MAIN OBJECTIVE:

Develop a Government goods classification scheme on a basis other than physical differences (Federal Supply Class) or the manufacturer (Standard Industrial Classification).

CONCEPTUAL BASIS FOR THE PROPOSED SCHEME:

By using a scheme of appropriate characteristics, one should be able to explain or define contracting policies and methods. To determine which characteristics are the best to use for classifying, the classifier could ask himself the following general question:

> Which characteristics of the goods, environment, and the process will offer the greatest strategic insights for the purpose of defining contracting policies and methods?

SPECIFIC USES:

Specifically, such a classification scheme could be used:

a. For the purposes of determining appropriate competitive environment elements (i.e. design competition, price competition, etc.)
b. For the purposes of determining the appropriate contract instrument to use. The structure should allow for a better relationship between product and contract instrument.
c. For the purposes of developing new methods of procurement. Is there a hybrid process between sealed bidding and competitive negotiation (other than 2-step sealed bid) that would be better?
d. For the purposes of highlighting those categories of goods which require less statutory and regulative oversight.

FOUR PRINCIPLES NECESSARY FOR A SUCCESSFUL CLASSIFICATION SYSTEM

1. The classification system must be capable of defining all existing items needed to meet end-use goals and it must be able to accept new items as defined without violating any principle given herein or causing the generation of a new classification system.
2. The classification system must be mutually exclusive, i.e., any item can be classified properly only in one place.

3. The classification system must be based on permanent characteristics.
4. The classification system must serve a purpose (end-use goal).

Enclosure (1)

QUESTIONS TO ASK TO DETERMINE THE APPROPRIATE CHARACTERISTICS

1. What are some of the distinguishable characteristics of the goods procured by the Federal Government?

2. Which properties or characteristics of the goods are the most important for classificatory purposes?

3. What should be the decision criteria for classifying Government purchased goods?

4. What are the various homogenous categories of goods procured by the Government?

5. Which classes or categories of goods are the most meaningful for classification and research?

6. In what specific areas of Government procurement will this classification scheme be useful?

Enclosure (2)

ATTRIBUTES EACH CHARACTERISTIC MUST POSSESS:

1. Differentiation (differentiates at least two classes).

2. Concomitance (be exclusive).

3. Relevance (to end-use goal).

4. Ascertainability (to the user).

5. Permanence (definable and unchangeable so long as the end use goal is unchanged).

6. Consistency (fixed and adhered to).

PRELIMINARY CHARACTERISTICS

1. Unit value.
2. Significance of each individual purchase to the Government.
3. Time and effort spent purchasing by the buyer.
4. Rate of technological change.
5. Technical complexity.
6. Need for service (before, during, or after sale).
7. Frequency of purchase.
8. Rapidity of consumption.
9. Extent of usage (number and variety of users and variety of ways in which the good provides utility).
10. Amount of price negotiation.
11. Alternative sources availability.
12. Degree of contractor financing required.
13. Amount of product homogeneity.
14. Factors considered by the buyer (price, quality, availability, and technology).
15. What determines price.
16. Amount of choice available to the buyer.
17. Stability of requirements.
18. Amount of short-range vs long-range planning involved.
19. Usage - planned and useful consumption or acquired as "insurance" (i.e., major weapon systems).
20. Extent to which goods are customized.
21. Extent to which buyer exercises judgement in meeting needs of requiring activity.
22. What is the nature of the demand for the good relative to the supply?

Enclosure (3)

APPENDIX B

CHARACTERISTICS ASSOCIATED WITH GOVERNMENT GOODS

1. **Change** describes the good's rate of technological transformation. With some goods, their rate of technological change is very low. Their design is fixed and rarely, if ever, changes. Contrast this with those goods that are affected by state-of-the art technology and are characterized by a high rate of technological obsolescence.

SCALE:

1 Very low rate of technological change
2 Low rate of technological change
3 Medium amount of technological change
4 High rate of technological change
5 Very high rate of technological change

2. **Complexity** describes the good's technical intricacies. The degree of a good's technical complexity may be thought of in terms of the skill and expertise needed to produce the good. Another way to determine complexity is whether the good is a system, sub-assembly, component, piece part, or raw material. For scoring purposes, 1 indicates little or no technological complexity with 5 being very high complexity.

SCALE:

1 Very low technical complexity
2 Low technical complexity
3 Medium technical complexity
4 High technical complexity
5 Very high technical complexity

3. **Customization** is the degree to which the good is manufactured to the buyer's specifications. Some goods, those that are strictly commercial, have no amount of customization while others are produced exclusively for a buyer, e.g. the Government. Goods that are not customized should be scored 1 with those developed exclusively for the Government scored 5.

SCALE:

1 No amount of customization
2 Low degree of customization
3 Medium amount of customization
4 High amount of customization
5 Made exclusively for the Government

4. **Maintainability** refers to the amount of maintenance considerations associated with the good. In other words, how frequently, if at all, is maintenance is required on the good. Some goods are virtually maintenance-free while others require a great deal of maintenance throughout their lives.

SCALE:

1 No maintenance required
2 Low maintenance requirements
3 Medium maintenance requirements
4 High maintenance requirements
5 Very high maintenance requirements

5. **Homogeneity** represents the number of other goods that are similar and are ready substitutes for the good under consideration. Typically, the more common the use of the good, the greater the amount of homogeneity. Highly homogeneous goods should be scored 1 and those with little or none scored 5.

SCALE:

1 Very high homogeneity
2 High homogeneity
3 Medium homogeneity
4 Low homogeneity
5 No homogeneity

6. **Consumption** refers to how rapidly the good is used by the buyer. Some goods are consumed on a continuing basis and require constant replenishment. Others are of a more permanent nature resulting in much less frequent buying. Rapidly consumed goods should be scored 1 and 5 used for goods that are rarely consumed or replaced.

SCALE:

1 Very rapidly consumed good, constant replenishment
2 Rapidly consumed good, constant replenishment
3 Moderate consumption and replenishment
4 Low rate of consumption and replenishment
5 Very low rate of consumption and replenishment

7. **Unit cost** is the good's cost to the buyer. Generally speaking, as a good becomes more unique to the buyer's requirement, the unit value is increasing. To score, use 1 for low unit cost and 5 for very high.

SCALE:

1 Very low unit cost
2 Low unit cost
3 Medium unit cost
4 High unit cost
5 Very high unit cost

8. **Documentation** is another characteristic external to the good yet many times a necessary part of it. Frequently

the Government requires substantiating documentation in the form of drawings, technical manuals, and certifications for some types of goods while for others little at all is required. When scoring, a 1 would indicate a good purchased with no accompanying documentation while 5 is for goods accompanied by drawings, technical manuals, etc.

SCALE:

1 No associated documentation
2 Low amount of documentation
3 Medium amount of documentation
4 Great deal of documentation
5 Very high amount of documentation

9. **Item attention** given by the buyer refers to single-item versus volume or mass buying. When a buyer deals with small dollar-value items like common bolts and rivets, the focus is on a mass quantity of these types of goods. Contrast this with the acquisition of a F-14 aircraft where the buyer's attention is focused on a single item.

SCALE:

1 Complete volume-type attention
2 Mostly volume-type attention
3 Good that could be either volume or single item
4 Good that is usually single-item attention
5 Good that is always single-item attention

10. **Sources of supply** refers to the number of available sources that provide the same basic type of good. Some types of goods have associated with them a great number of alternate sources while others of a more specialized nature are more restrictive.

SCALE:

1 Virtually unlimited number of suppliers
2 High number of suppliers
3 Adequate number of suppliers
4 One or two sources
5 No sources exist

11. **Criticality** refers to the buying urgency associated with the good or the necessity of having the good available for the buyer to purchase. This characteristic of a good can be quite dynamic, but some goods, by their nature, may rarely be characterized as critical to the buyer.

SCALE:

1 Never characterized as a critical item
2 Rarely a critical item
3 Sometimes approached as critical
4 Usually characterized as critical
5 Always purchased under critical situations

12. **Stability** refers to the nature of the requirement. With some goods their demand is constant and seldom varies. On the other hand, demand for certain types of goods is much more volatile and uncertain depending on the need for the good and perhaps the technology that is available.

SCALE:

1	Good that is extremely stable
2	High degree of stability
3	Moderate amount of stability
4	Low amount of stability
5	Highly unstable good

GOODS & CHARACTERISTICS

Goods \ Characteristics	1. CHANGE	2. COMPLEXITY	3. CUSTOMIZATION	4. MAINTAINABILITY	5. HOMOGENEITY	6. CONSUMPTION	7. UNIT COST	8. DOCUMENTATION	9. ITEM ATTENTION	10. SOURCES	11. CRITICALITY	12. STABILITY	13. IMPORTANT CHARACTERISTICS & PRIORITY	14. COMMENTS
1. Steam Turbine	3	3	3	3	2	4	3	4	4	3	2	3	9-6-2	
2. Microcomputer (general office)														
3. Fork Lift Truck														
4. Guided Missile														
5. Electronic Countermeasure Equipment														
6. Paper Towel Dispenser														
7. Pneumatic Chisel														
8. Floating Drydock														
9. 16mm Film Projector														
10. Cold Food Counter														
11. Submarine Periscope														
12. Filing Cabinet														
13. Sandpaper														
14. Aircraft Gunnery Fire-Control Embedded Computer														
15. Bottled Salad Dressing														
16. Nuclear Reactor														
17. Semiconductor Assembly														
18. Shipboard Washing Machine														
19. Flourescent Light Tube														
20. Pneumatic Tire (non-aircraft)														
21. Micrometer (general purpose)														
22. Flat Washers														

APPENDIX C

The mean value matrix shown in Table C-1 was used as the basis for cluster analysis of the 21 sample goods. It represented the input from the 54 respondents regarding the relationships between the characteristics and the goods.

The researcher used a computer spreadsheet program to recast the respondent completed grids into 21 separate matrices (one for each good). These matrices related the respndent's code on the vertical axis with the 12 characteristics across the horizontal axis. After subdividing the 54 completed grids in this fashiion, they were all recombined into a single matrix by averaging the individual cell scores. Table C-1 is the resultant outcome from this averaging process.

TABLE C-1

Mean Value Matrix
Source: Researcher's Analysis

GOOD	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12
Microcomp	4.35	3.81	2.19	2.63	2.46	3.85	2.94	3.07	2.89	2.31	2.31	2.89
Fork Truc	1.65	2.28	1.98	2.93	2.26	4.07	3.11	2.67	2.85	2.70	2.13	2.17
Missile	4.41	4.76	4.80	4.09	4.35	3.42	4.81	4.93	4.09	3.56	3.93	4.00
ECM Equip	4.76	4.85	4.69	4.39	4.31	3.98	4.63	4.81	4.06	3.57	3.91	4.07
P.Towel D.	1.02	1.04	1.17	1.21	1.43	3.60	1.04	1.06	1.28	1.36	1.00	1.11
Pneu. Chs.	1.77	1.98	1.51	2.17	1.92	3.48	2.06	1.92	2.15	2.17	1.75	1.74
Floating	1.85	2.52	3.17	3.04	3.35	4.40	4.17	3.37	4.21	3.54	2.92	2.96
Film Proj	1.85	2.11	1.49	2.02	2.04	3.87	1.96	2.04	2.23	2.25	1.45	1.68
Food Coun.	1.62	1.64	1.78	1.82	2.06	4.20	2.28	1.80	2.52	2.38	1.58	1.52
Periscope	3.31	3.58	4.50	3.54	4.23	4.24	4.13	4.29	3.83	3.75	3.67	3.29
Flng. Cab.	1.09	1.17	1.32	1.26	1.49	3.98	1.55	1.21	1.38	1.40	1.19	1.09
Sandpaper	1.08	1.04	1.15	1.02	1.42	1.45	1.00	1.00	1.11	1.19	1.08	1.02
F/C Compu	4.43	4.65	4.83	4.37	4.57	4.13	4.54	4.67	4.07	3.65	3.93	3.91
Salad Dre	1.31	1.21	1.26	1.06	1.30	1.38	1.08	1.06	1.06	1.21	1.06	1.06
Nuclear R	3.77	4.74	4.45	4.75	4.42	4.57	4.94	4.98	4.83	3.81	4.17	3.98
Semicondu	4.22	4.00	3.63	2.86	3.39	3.39	3.04	3.14	2.84	2.88	3.02	3.08
Wshg Mach.	1.80	2.10	3.02	2.57	2.69	3.65	2.43	2.47	2.57	2.75	2.10	2.24
Fluoresce	1.34	1.42	1.25	1.18	1.47	2.13	1.09	1.02	1.17	1.60	1.26	1.21
Tire	1.58	1.52	1.54	1.63	1.75	2.19	1.73	1.37	1.50	1.90	1.75	1.50
Micromete	1.83	2.13	1.62	1.71	1.90	3.83	1.81	1.77	1.92	2.12	1.69	1.63
Flat Wash	1.02	1.04	1.23	1.00	1.45	1.64	1.00	1.04	1.08	1.11	1.21	1.15

C1 - Change
C2 - Complexity
C3 - Customization
C4 - Maintainability
C5 - Homogeneity
C6 - Consumption
C7 - Unit Cost
C8 - Documentation
C9 - Item Attention
C10 - Sources
C11 - Criticality
C12 - Stability

APPENDIX D

Following somewhat the same procedure used in constructing the mean value matrix, the researcher calculated the standard deviation matrix shown in Table D-1. The values shown in this matrix represent the variation in the scores for each of the respondent completed grids.

Two additional calculations were added to this matrix. The row labelled "# > 1" refers to those goods in the various attribute columns that had a standard deviation greater than one. For example, regarding "customization," two goods, floating drydock and the shipboard washing machine, had a standard deviation of 1.10 and 1.27 respectively. The next row, "Avg S.Dev" represents the average standard deviation for each of the 12 attributes. Using this measure of analysis, "documentation" was the most consistently applied attribute since its average standard deviation was the lowest at .54.

Examining the attributes and scores in this fashion allowed for determining which attributes were consistently applied by the respondents.

TABLE D-1

Standard Deviation Matrix
Source: Researcher's Analysis

GOOD	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12
Microcomp	0.62	0.65	0.99	0.78	1.06	0.86	0.68	0.70	0.72	0.58	0.58	0.78
Fork Truc	0.68	0.63	0.88	0.67	1.07	0.97	0.86	0.82	0.68	0.46	0.55	0.72
Missile	0.63	0.43	0.66	1.01	0.95	1.41	0.39	0.26	1.05	0.54	0.77	0.82
ECM Equip	0.43	0.36	0.72	0.79	1.06	1.04	0.65	0.48	0.92	0.54	0.83	0.70
Paper Tow	0.14	0.19	0.61	0.41	0.99	1.43	0.19	0.30	0.63	0.62	0.00	0.32
Pneumatic	0.70	0.60	0.70	0.64	0.73	0.90	0.69	0.65	0.79	0.70	0.59	0.65
Floating	0.67	0.80	1.10	0.88	1.19	1.07	0.98	1.31	1.00	0.67	0.76	1.14
Film Proj	0.74	0.54	0.80	0.46	1.19	0.94	0.73	0.44	0.80	0.65	0.50	0.64
C. Food C	0.67	0.69	0.86	0.60	0.93	1.09	0.76	0.57	0.99	0.73	0.61	0.61
Periscope	0.83	0.78	0.80	0.87	0.98	0.93	0.89	0.82	0.92	0.44	0.73	0.89
Filing Ca	0.35	0.38	0.70	0.49	1.01	1.35	0.54	0.45	0.53	0.63	0.44	0.30
Sandpaper	0.27	0.19	0.63	0.14	0.99	1.20	0.00	0.00	0.61	0.44	0.27	0.14
F/C Compu	0.63	0.65	0.61	0.83	0.60	0.94	0.72	0.67	1.03	0.59	0.77	0.81
Salad Dre	0.61	0.49	0.74	0.31	0.80	1.00	0.55	0.42	0.30	0.45	0.23	0.23
Nuclear R	0.89	0.52	0.64	0.48	0.80	1.05	0.23	0.14	0.43	0.52	1.01	1.17
Semicondu	0.78	0.82	0.92	1.15	0.72	0.90	0.94	1.13	0.95	0.65	0.62	0.69
Washing M	0.75	0.76	1.27	0.64	0.93	0.82	0.73	0.64	0.73	0.72	0.73	0.79
Fluoresce	0.59	0.66	0.68	0.43	1.03	1.23	0.56	0.14	0.64	0.74	0.56	0.53
Tire (non	0.67	0.67	0.73	0.77	1.08	0.91	0.63	0.60	0.75	0.75	0.65	0.67
Micromete	0.94	0.99	0.87	0.72	1.05	1.13	0.69	0.58	0.81	0.70	0.67	0.60
Flat Wash	0.14	0.19	0.67	0.00	1.10	1.30	0.00	0.19	0.55	0.38	0.49	0.46
# > 1	0	0	2	2	10	12	0	2	3	0	1	2
Avg S.Dev	0.61	0.57	0.79	0.62	0.97	1.07	0.59	0.54	0.75	0.59	0.59	0.65

C1 - Change
C2 - Complexity
C3 - Customization
C4 - Maintainability
C5 - Homogeneity
C6 - Consumption
C7 - Unit Cost
C8 - Documentation
C9 - Item Attention
C10 - Sources
C11 - Criticality
C12 - Stability

APPENDIX E

DATA COLLECTION SCHEME

Figure E-1 is the revised data collection matrix to use in conjunction with the characteristic definitions and scales. Individual scorers would review the goods in relation to the six attributes listed across the top of the matrix. Then, depending on the nature of the relationship, the appropriate 1 - 5 score would be indicated in the particular cells.

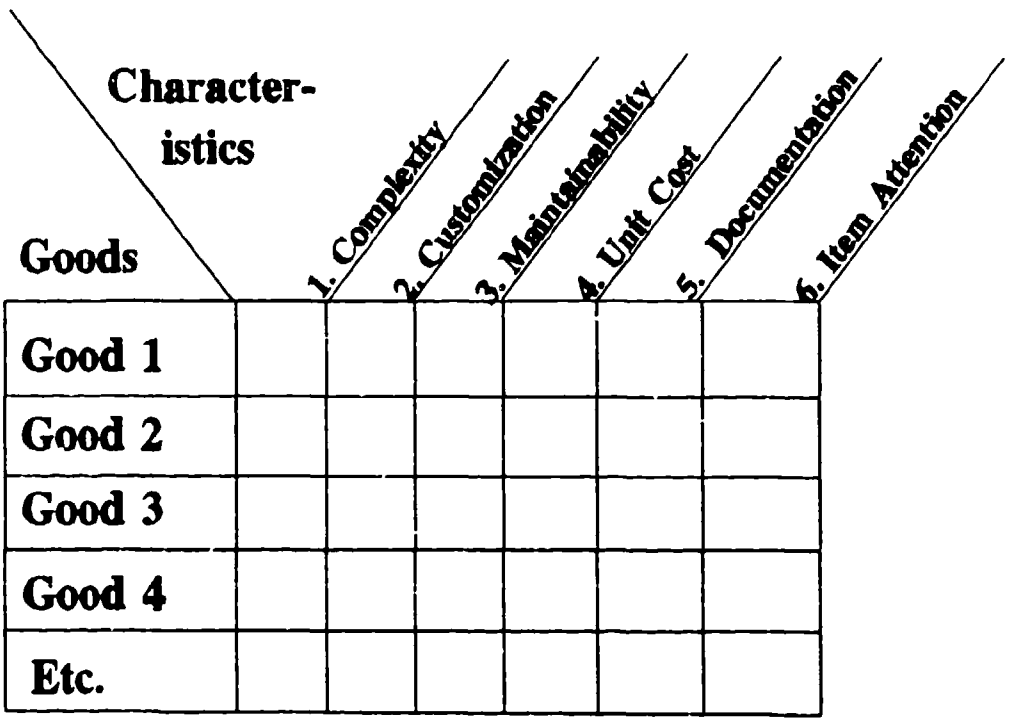

FIGURE E-1

Data Collection Matrix
Source: Researcher's Analysis

CHARACTERISTIC DEFINITION AND SCALES

Complexity describes the good's technical intricacies. The degree of a good's technical complexity may be thought of in terms of the skill and expertise needed to produce the good. Another way to determine complexity is whether the good is a system, sub-assembly, component, piece part, or raw material. For scoring purposes, 1 indicates little or no technological complexity with 5 being very high complexity.

SCALE:

1	Very low technical complexity
2	Low technical complexity
3	Medium technical complexity
4	High technical complexity
5	Very high technical complexity

Customization is the degree to which the good is manufactured to the buyer's specifications. Some goods, those that are strictly commercial, have no amount of customization while others are produced exclusively for a buyer, e.g. the Government. Goods that are not customized should be scored 1 with those developed exclusively for the Government scored 5.

SCALE:

1	No amount of customization
2	Low degree of customization
3	Medium amount of customization
4	High amount of customization
5	Made exclusively for the Government

Maintainability refers to the amount of maintenance considerations associated with the good. In other words, how frequently, if at all, is maintenance is required on the good. Some goods are virtually maintenance-free while others require a great deal of maintenance throughout their lives.

SCALE:

1	No maintenance required
2	Low maintenance requirements
3	Medium maintenance requirements
4	High maintenance requirements
5	Very high maintenance requirements

Unit cost is the good's cost to the buyer. Generally speaking, as a good becomes more unique to the buyer's requirement, the unit cost is increasing. To score, use 1 for low unit cost and 5 for very high.

SCALE:

1	Very low unit cost
2	Low unit cost
3	Medium unit cost
4	High unit cost
5	Very high unit cost

Documentation is another characteristic external to the good yet many times a necessary part of it. Frequently the Government requires substantiating documentation in the form of drawings, technical manuals, and certifications for some types of goods while for others little at all is required. When scoring, a 1 would indicate a good purchased with no accompanying documentation while 5 is for goods accompanied by drawings, technical manuals, etc.

SCALE:

1	No associated documentation
2	Low amount of documentation
3	Medium amount of documentation
4	Great deal of documentation
5	Very high amount of documentation

Item attention given by the buyer refers to single-item versus volume or mass buying. When a buyer deals with small dollar-value items like common bolts and rivets, the focus is on a mass quantity of these types of goods. Contrast this with the acquisition of a F-14 aircraft where the buyer's attention is focused on a single item.

SCALE:

1	Complete volume-type attention
2	Mostly volume-type attention
3	Good that could be either volume or single item
4	Good that is usually single-item attention
5	Good that is always single-item attention

CLASSIFICATION SCHEME

Once the results of the survey have been received and averaged, a classification matrix would be completed for each good. Figure E-2 shows the proposed scheme for classifying Government goods into one of five categories.

Good: **N =**

	Avg Value	Categories: Simple (1.00-1.80)	Basic (1.81-2.60)	Moderate (2.61-3.40)	Advanced (3.41-4.20)	Complex (4.21-5.00)
Complexity						
Customization						
Maintainability						
Unit Cost						
Documentation						
Item Attention						
Overall Score						

KEY:
+ : UPPER END OF THE CATEGORY
0 : MIDDLE OF THE CATEGORY
- : LOWER END OF THE CATEGORY

FIGURE E-2

Individual Good Classification Scheme
Source: Researcher's Analysis

APPENDIX F

To demonstrate the use of the classification scheme, the 21 sample goods used in this study are categorized below. The numbers shown in the "Avg Value" column represent the data collected from the 54 respondents.

Good: Sandpaper **N =54**

	Avg Value	Categories: Simple (1.00-1.80)	Basic (1.81-2.60)	Moderate (2.61-3.40)	Advanced (3.41-4.20)	Complex (4.21-5.00)
Complexity	1.04	-				
Customization	1.15	-				
Maintainability	1.02	-				
Unit Cost	1.00	-				
Documentation	1.00	-				
Item Attention	1.11	-				
Overall Score	1.05	-				

Good: Flat washer N =54

	Avg Value	Categories: Simple (1.00-1.80)	Basic (1.81-2.60)	Moderate (2.61-3.40)	Advanced (3.41-4.20)	Complex (4.21-5.00)
Complexity	1.04	-				
Customization	1.23	-				
Maintainability	1.00	-				
Unit Cost	1.00	-				
Documentation	1.04	-				
Item Attention	1.08	-				
Overall Score	1.07	-				

Good: Bottled salad dressing N =54

	Avg Value	Categories: Simple (1.00-1.80)	Basic (1.81-2.60)	Moderate (2.61-3.40)	Advanced (3.41-4.20)	Complex (4.21-5.00)
Complexity	1.21	-				
Customization	1.26	-				
Maintainability	1.06	-				
Unit Cost	1.08	-				
Documentation	1.06	-				
Item Attention	1.06	-				
Overall Score	1.12	-				

Good: Paper towel dispenser N =54

	Avg Value	Categories: Simple (1.00-1.80)	Basic (1.81-2.60)	Moderate (2.61-3.40)	Advanced (3.41-4.20)	Complex (4.21-5.00)
Complexity	1.04	-				
Customization	1.17	-				
Maintainability	1.21	-				
Unit Cost	1.04	-				
Documentation	1.06	-				
Item Attention	1.28	0				
Overall Score	1.13	-				

Good: Filing cabinet N =54

	Avg Value	Categories: Simple (1.00-1.80)	Basic (1.81-2.60)	Moderate (2.61-3.40)	Advanced (3.41-4.20)	Complex (4.21-5.00)
Complexity	1.17	-				
Customization	1.32	0				
Maintainability	1.26	-				
Unit Cost	1.55	+				
Documentation	1.21	-				
Item Attention	1.39	0				
Overall Score	1.32	0				

Good: Fluorescent light tube N =54

	Avg Value	Categories: Simple (1.00-1.80)	Basic (1.81-2.60)	Moderate (2.61-3.40)	Advanced (3.41-4.20)	Complex (4.21-5.00)
Complexity	1.42	0				
Customization	1.25	-				
Maintainability	1.18	-				
Unit Cost	1.09	-				
Documentation	1.02	-				
Item Attention	1.17	-				
Overall Score	1.19	-				

Good: Pneumatic tire N =54

	Avg Value	Categories: Simple (1.00-1.80)	Basic (1.81-2.60)	Moderate (2.61-3.40)	Advanced (3.41-4.20)	Complex (4.21-5.00)
Complexity	1.52	0				
Customization	1.54	0				
Maintainability	1.63	+				
Unit Cost	1.73	+				
Documentation	1.37	0				
Item Attention	1.51	0				
Overall Score	1.55	+				

Good: Pneumatic chisel N =54

	Avg Value	Categories: Simple (1.00-1.80)	Basic (1.81-2.60)	Moderate (2.61-3.40)	Advanced (3.41-4.20)	Complex (4.21-5.00)
Complexity	1.98		-			
Customization	1.81		-			
Maintainability	2.17		0			
Unit Cost	2.06		-			
Documentation	1.92		-			
Item Attention	2.15		0			
Overall Score	1.97		-			

Good: 16mm film projector N =54

	Avg Value	Categories: Simple (1.00-1.80)	Basic (1.81-2.60)	Moderate (2.61-3.40)	Advanced (3.41-4.20)	Complex (4.21-5.00)
Complexity	2.11		0			
Customization	1.49	0				
Maintainability	2.02		-			
Unit Cost	1.96		-			
Documentation	2.04		-			
Item Attention	2.23		0			
Overall Score	1.98		-			

Good: Micrometer (general purpose) N =54

	Avg Value	Categories: Simple (1.00-1.80)	Basic (1.81-2.60)	Moderate (2.61-3.40)	Advanced (3.41-4.20)	Complex (4.21-5.00)
Complexity	2.13		0			
Customization	1.62	+				
Maintainability	1.71	+				
Unit Cost	1.81		-			
Documentation	1.77	+				
Item Attention	1.92		-			
Overall Score	1.83		-			

Good: Cold food counter N =54

	Avg Value	Categories: Simple (1.00-1.80)	Basic (1.81-2.60)	Moderate (2.61-3.40)	Advanced (3.41-4.20)	Complex (4.21-5.00)
Complexity	1.64	+				
Customization	1.78	+				
Maintainability	1.82		-			
Unit Cost	2.28		0			
Documentation	1.80	+				
Item Attention	2.52		+			
Overall Score	1.97		-			

Good: Fork lift truck N =54

	Avg Value	Categories: Simple (1.00-1.80)	Basic (1.81-2.60)	Moderate (2.61-3.40)	Advanced (3.41-4.20)	Complex (4.21-5.00)
Complexity	2.28		0			
Customization	1.98		-			
Maintainability	2.93			0		
Unit Cost	3.11			0		
Documentation	2.67			-		
Item Attention	2.85			0		
Overall Score	2.64			-		

Good: Shipboard washing machine N =54

	Avg Value	Categories: Simple (1.00-1.80)	Basic (1.81-2.60)	Moderate (2.61-3.40)	Advanced (3.41-4.20)	Complex (4.21-5.00)
Complexity	2.10		0			
Customization	3.02			0		
Maintainability	2.57		+			
Unit Cost	2.43		+			
Documentation	2.47		+			
Item Attention	2.57		+			
Overall Score	2.53		+			

Good: Microcomputer (general office) N =54

	Avg Value	Simple (1.00-1.80)	Basic (1.81-2.60)	Moderate (2.61-3.40)	Advanced (3.41-4.20)	Complex (4.21-5.00)
		Categories				
Complexity	3.81				0	
Customization	2.19		0			
Maintainability	2.63			-		
Unit Cost	2.94			0		
Documentation	3.07			0		
Item Attention	2.89			0		
Overall Score	2.92			0		

Good: Semi-conductor assembly N =54

	Avg Value	Simple (1.00-1.80)	Basic (1.81-2.60)	Moderate (2.61-3.40)	Advanced (3.41-4.20)	Complex (4.21-5.00)
		Categories				
Complexity	4.00				+	
Customization	3.63				-	
Maintainability	2.86			-		
Unit Cost	3.04			0		
Documentation	3.14			0		
Item Attention	2.84			-		
Overall Score	3.25			+		

Good: Floating drydock N =54

	Avg Value	Categories: Simple (1.00-1.80)	Basic (1.81-2.60)	Moderate (2.61-3.40)	Advanced (3.41-4.20)	Complex (4.21-5.00)
Complexity	2.52		+			
Customization	3.17			+		
Maintainability	3.04			0		
Unit Cost	4.17				+	
Documentation	3.37			+		
Item Attention	4.21					-
Overall Score	3.41				-	

Good: Submarine periscope N =54

	Avg Value	Categories: Simple (1.00-1.80)	Basic (1.81-2.60)	Moderate (2.61-3.40)	Advanced (3.41-4.20)	Complex (4.21-5.00)
Complexity	3.58				-	
Customization	4.50					0
Maintainability	3.54				-	
Unit Cost	4.13				+	
Documentation	3.83				0	
Item Attention	4.29					-
Overall Score	3.98				+	

Good: Nuclear reactor N =54

	Avg Value	Categories: Simple (1.00-1.80)	Basic (1.81-2.60)	Moderate (2.61-3.40)	Advanced (3.41-4.20)	Complex (4.21-5.00)
Complexity	4.74					+
Customization	4.45					-
Maintainability	4.75					+
Unit Cost	4.94					+
Documentation	4.98					+
Item Attention	4.83					+
Overall Score	4.78					+

Good: ECM equipment N =54

	Avg Value	Categories: Simple (1.00-1.80)	Basic (1.81-2.60)	Moderate (2.61-3.40)	Advanced (3.41-4.20)	Complex (4.21-5.00)
Complexity	4.84					+
Customization	4.69					0
Maintainability	4.39					-
Unit Cost	4.63					0
Documentation	4.81					+
Item Attention	4.08				+	
Overall Score	4.57					0

Good: Aircraft F/C computer N =54

	Avg Value	Simple (1.00-1.80)	Basic (1.81-2.60)	Moderate (2.61-3.40)	Advanced (3.41-4.20)	Complex (4.21-5.00)
		Categories				
Complexity	4.65					0
Customization	4.83					+
Maintainability	4.37					-
Unit Cost	4.54					0
Documentation	4.67					0
Item Attention	4.07				+	
Overall Score	4.52					0

Good: Guided missile N =54

	Avg Value	Simple (1.00-1.80)	Basic (1.81-2.60)	Moderate (2.61-3.40)	Advanced (3.41-4.20)	Complex (4.21-5.00)
		Categories				
Complexity	4.76					+
Customization	4.80					+
Maintainability	4.09				+	
Unit Cost	4.81					+
Documentation	4.93					+
Item Attention	4.09				+	
Overall Score	4.58					0

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